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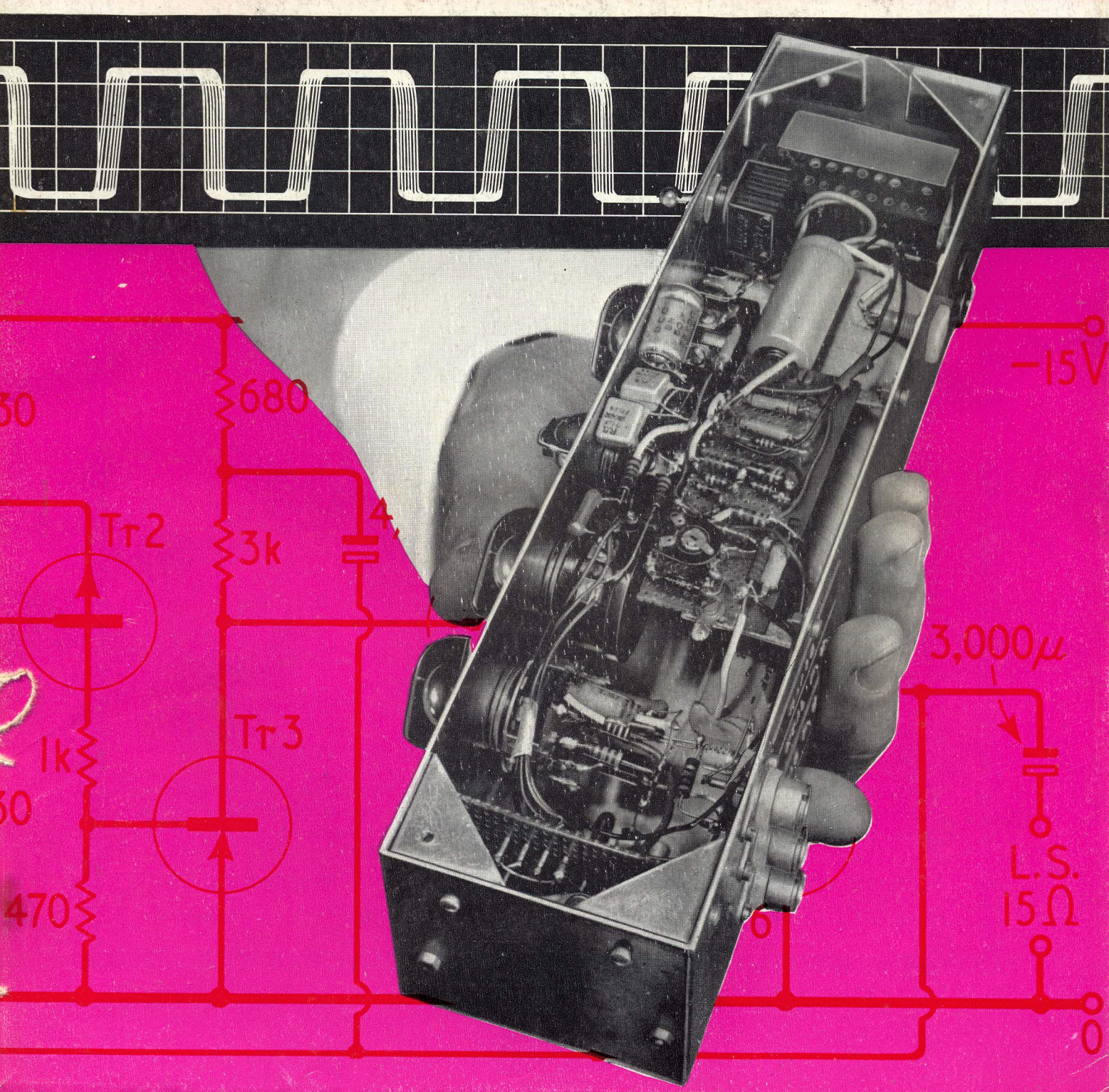

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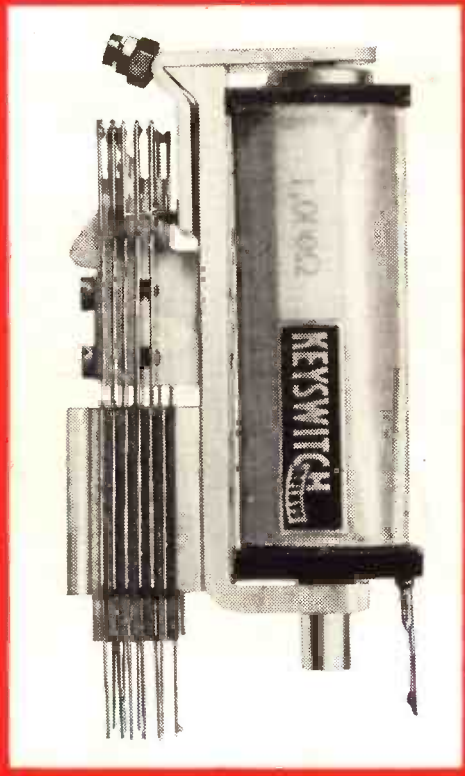

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APRIL 1965

159 Editorial Comment

160 A Feedback Pulse Width Modulated Audio Amplifier *By G. F. Turnbull and J. M. Townsend*

169 Matrix Algebra—2 *By G. H. Olsen*

172 This Month's Conferences and Exhibitions

173 Manufacturers' Products

179 World of Wireless

181 Personalities

183 News from Industry

185 Physical Society Exhibition—List of Exhibitors

185 H.F. Predictions—April

186 Audio Fair Preview

193 Letters to the Editor

198 Electronic Laboratory Instrument Practice—4 *By T. D. Towers*

203 Books Received

204 Audible Rate-of-Climb Indicator *By J. M Firth*

206 Real and Imaginary *By "Vector"*

207 Commercial Literature

208 April Meetings

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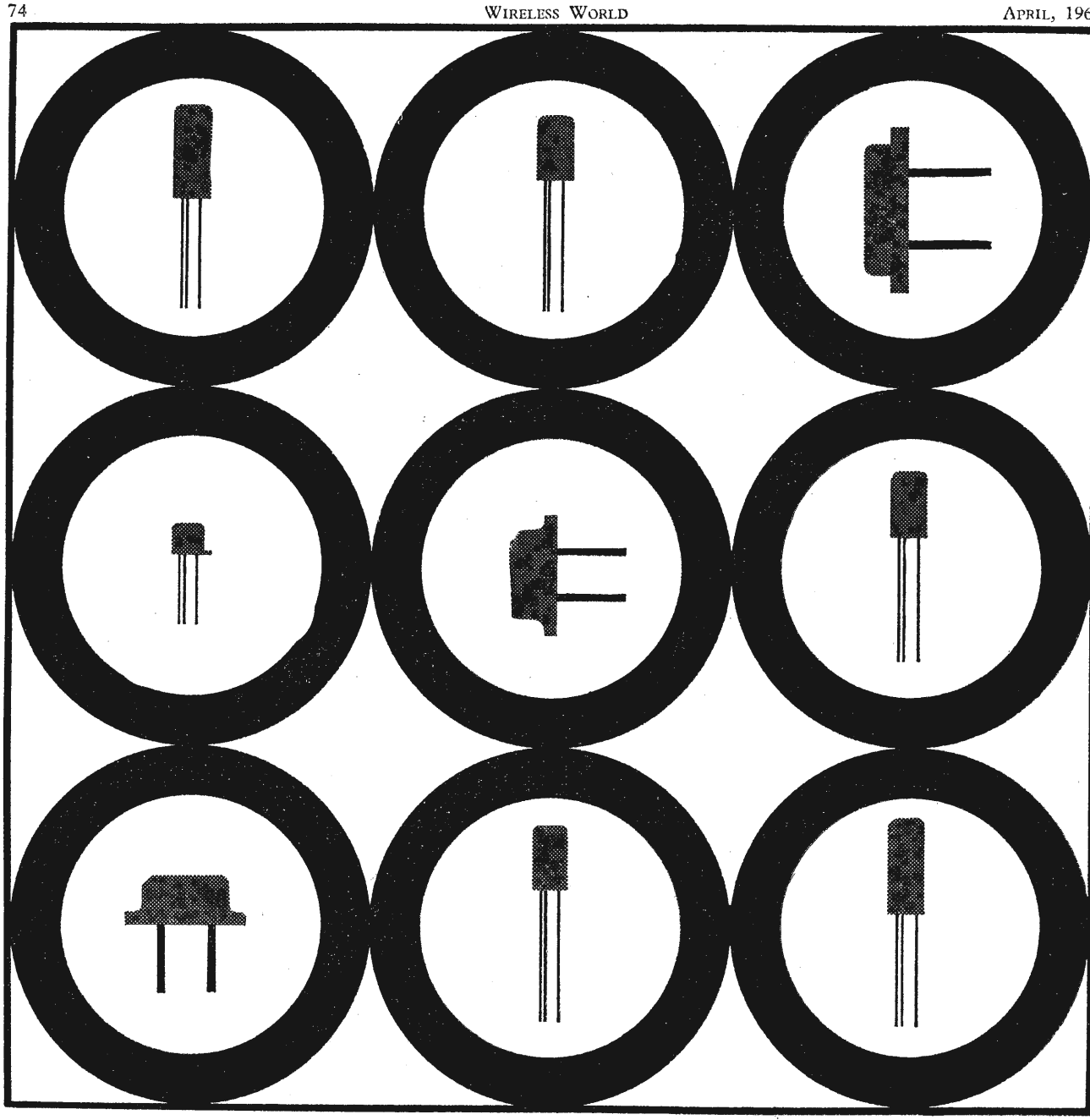

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Audio Topics

WHAT will be the topics of conversation (occasionally of declamation) to be heard among the knots of enthusiasts as they move from floor to floor of the Audio Festival and Fair demonstrations at the Russell Hotel in London this month? Headphones *versus* loudspeakers, cross-field magnetic recording? Almost certainly transistor amplifiers of every class from A to D (pulse width modulated).

The choice of circuitry for transistor high-quality amplifiers is wider than ever and we foresee much argument between the devotees of what must now be regarded as the tried basic conventional designs of Toby and Dinsdale, Tharma and Osborne, and the modulated pulse amplifiers stimulated by D. R. Birt's article in this journal two years ago and represented in this issue by the design described by G. F. Turnbull and J. M. Townsend.

The advent of the transistor has reopened argument about the power ratings of amplifiers. This interests us not only because it is a frequent cause of wrangles between advertisers and customers (in spite of the fact that most of our readers are sufficiently well informed to apply the principle of *caveat emptor* effectively) but because it has shown how our attitudes and judgments in matters of this kind are conditioned by precedent.

Power in electrical engineering is the root-mean-square power of a sine wave. What more natural, then, than to rate an amplifier on the same basis, even though it is not normally used to boil an egg, make tea or even to reproduce sine waves?

No one is going to argue that an amplifier which will be called upon to reproduce music at a satisfying level in an average living room is any the worse for being able to sustain indefinitely an undistorted sine-wave power of, say, 10 watts r.m.s. which, incidentally, means that 20 watts peak power will be touched twice in every cycle. On music it will be called upon to touch peak power less than 1% of the time and the average power will be 20 dB below this, or 200 milliwatts if one is a purist and insists on preserving the dynamic range of the original sound. But the B.B.C. and the gramophone recording companies are not giving you the original peak powers anyway. If they did their service areas would shrink and the record groove walls would break down; both know to a nicety just how to fit good sound between the limits of background noise and overmodulation.

Thinking like electrical engineers in terms of sine-wave power has hitherto done no one any harm because valve amplifiers are robust pieces of equipment, at least in the sense that if you don't drop them you can abuse them in the matter of occasional overloading and mishaps with bias and in ninety-nine times out of a hundred get away with it with no more to show than a slight brightening of the glow of the anodes.

Habits of thought induced by long experience with valves are likely not only to be wrong but costly when applied to transistor amplifiers. Basically the difference is in the size and accessibility of the heat generating surfaces in valves and solid-state devices; the semiconductor solids are poor conductors, the junctions are buried and are also more vulnerable to heat. So the limiting factor is the junction temperature and the temperature gradients between it and the heat sinks. While the junction may be capable of handling the normal quota of peaks met with in music it may not survive sustained sine-wave power at the full output. Allowing generously for compression of dynamic range at the source, a ratio of 10dB between peak and average power could mean that a 10 watt (peak) amplifier might be required to run (and be tested) at the equivalent of a sustained sine-wave r.m.s. power of only 50 milliwatts. It all depends on the type of circuit and the rating of the transistors used.

Clearly there is a need for rethinking on the rating of transistor amplifiers and the old single figure accepted for valve amplifiers may no longer be sufficient. For class A and B transistor amplifiers we can still give one (possibly small) figure for sustained power performance at a specified distortion level, but the question of testing for distortion at peak powers is one which still needs to be settled.

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A Feedback Pulse Width Modulated

By G. F. TURNBULL,* M.Sc., and J. M. TOWNSEND,* M.Sc.

THE advantages of on-off control systems, that is systems in which the power is controlled by a two-state switch, have been recognized for a long time in industrial applications, but only recently has serious consideration been given to the possibility of audio power amplification using the technique, the main problem being the difficulty of obtaining a suitable switch capable of operation at a high enough frequency.

The biggest advantage possessed by systems of this type is that large powers can be controlled by switches which themselves dissipate only a small amount of power. The overall power efficiency of the amplifying system is thus increased compared with the conventional (i.e. continuous control) type of power amplifier. Other advantages of the on-off type of system, compactness for example, stem from this principal fact, which enables heat dissipating surfaces of large physical size to be dispensed with.

The switching frequency of such systems must be several times higher than the highest frequency to be amplified, which may be taken as 20kc/s for audio work. Mechanical switches are therefore completely impracticable.

It has recently become possible to use both transistors and valves as switches at these frequencies but with valves the voltage and current values for a given power are not suitable to enable them to be coupled directly to a loudspeaker unless a special loudspeaker having a voice coil resistance of about 1kΩ is used and these are relatively expensive. Transistors, however, are basically high current, low voltage devices which makes them ideal for coupling directly to the low impedance of a loudspeaker.

This article describes the development of a transistor low power feedback audio amplifier which employs on-off control of the loudspeaker and has a simple circuit which is not particularly critical on component tolerances, and is quite simple to set up to the required operating conditions.

A simple form of on-off control of a loudspeaker is shown in Fig. 1(a), where the loudspeaker is connected by a switch to a voltage source. The voltage waveform appearing across the loudspeaker is shown in Fig. 1(b). The average value of the loudspeaker voltage is given by:—

$$V_L = \frac{VT_1}{T_1 + T_2}$$

where T_1 and T_2 are respectively the times for which the switch remains closed and for which it remains open. The mean level of the loudspeaker voltage can thus be varied by alteration of the ratio of the times T_1 and T_2. In an audio amplifying system this variation will be produced by the audio signal. The general form of the amplifier will thus be that shown in Fig. 1(c), where the switch is operated by a signal derived by addition of the audio signal and the switching waveform which is a continuous oscillation. This is shown graphically in Fig. 1(d). The switch is shown as possessing a certain amount of hysteresis (i.e. the point at which it changes state is dependent upon the direction of the change). This is a necessary feature of a two-state switch in order to ensure positive changes of state at well defined points on the characteristic.

For a fixed switching waveform it is possible to draw a curve relating the mean level of the load voltage to the instantaneous value of the audio signal. This curve can then be considered as the input *versus* output curve for the non-linearity (in this case the switch) modified by the switching waveform.

The exact shape of the modified non-linearity will depend upon the particular switching waveform used and it is possible to calculate the curve for any waveform. The best switching waveform to use is that which gives a linear input *versus* output curve, since any curvature of the amplifier characteristic will cause harmonic distortion of the audio signal. It can be shown that a switching waveform which is a symmetrical triangle will give a modified non-linearity which is exactly linear between two limits which are set by the ratio of the hysteretic width of the switch (2δ) to the pk-pk height ($\triangle$) of the triangular switching waveform (see Appendix 1). The modified non-linearity for a hysteretic switch for two

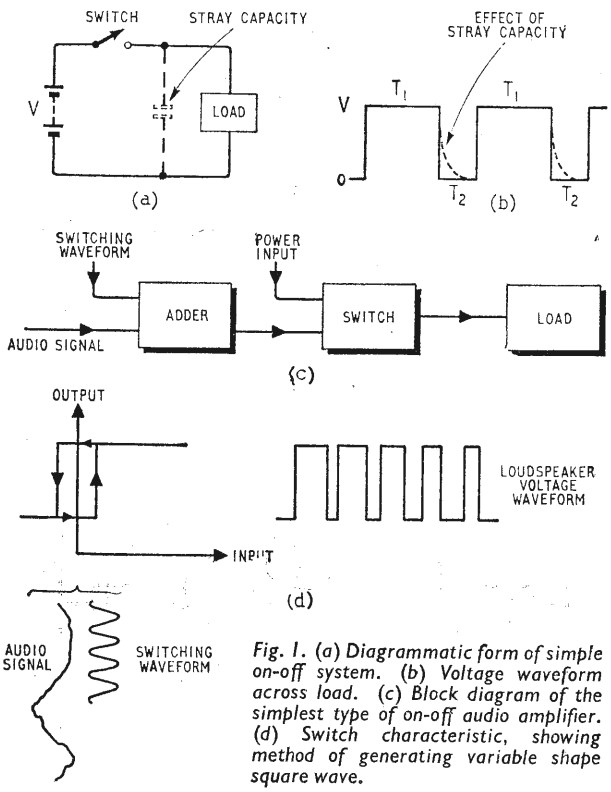

Fig. 1. (a) Diagrammatic form of simple on-off system. (b) Voltage waveform across load. (c) Block diagram of the simplest type of on-off audio amplifier. (d) Switch characteristic, showing method of generating variable shape square wave.

*Electrical Engineering Laboratories, Manchester University.

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Audio Amplifier

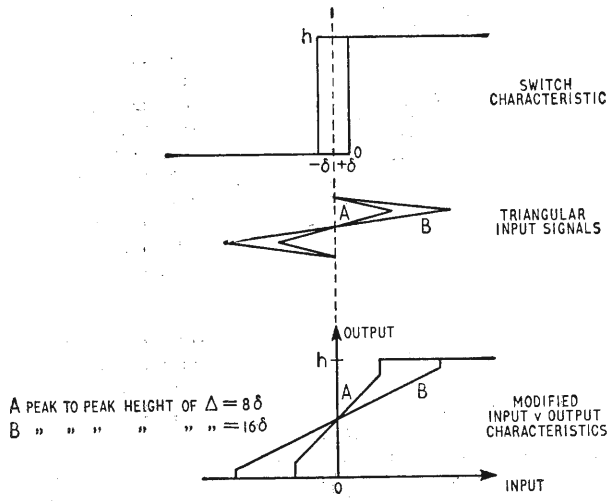


Fig. 2. Modified input versus output curves for a hysteretic switch operated by triangular waves of different sizes.

values of $\triangle$ is shown in Fig. 2. As can be seen, for $\triangle = 8\delta$ the effective gain through the modified non-linearity is greater than for $\triangle = 16\delta$, but the range of control is reduced because of the effect of the hysteresis of the switch. In order to obtain both high gain and full range of output level, the hysteretic width must be made very small. The most direct implementation of on-off control would thus use a switch with very low hysteresis, switched by a waveform generated by the addition of a very small triangle and the audio signal.

Before a system can be designed, however, it is necessary to decide upon the exact form to be taken by the switch. In general, the simple type of switch shown in Fig. 1(a) suffers from several disadvantages. The biggest of the disadvantages arises from the fact that when the system is operating at the centre of the linear region, as would be the case, for example, when no audio signal were present, there is a mean current V/2R flowing in the load, since $T_1 = T_2$. This results in the loudspeaker being displaced from its normal equilibrium position and may alter the loudspeaker characteristics and introduce distortion of the audio signals. A further disadvantage of the simple system is that stray capacity across the load will cause the square wave to be asymmetrical. This is shown dotted in Fig. 1(b). This asymmetry will cause curvature of the modified non-linear characteristic and, therefore, distortion to the audio signal which is again undesirable.

The disadvantages of the simple switch are largely overcome in the double switch system shown in Fig. 3(a). The practical implementation of this system can be achieved by following a simple switch (operated by the triangular waveform) by the arrangement shown in Fig. 3(b). Since the load is driven in both directions from a low impedance source the effect of stray capacity is very much reduced, and is approximately the same on both edges. The square wave across the load, when $T_1 = T_2$, has a mean level of zero and since in audio applications the d.c. component of the audio signal is always zero, the loudspeaker load can in fact be driven *via* a capacitor. In this case the battery supply need not be centre tapped, the load being returned to either the positive or the negative end of the supply. As stated earlier, the frequency of operation of the switch must be greater than 20 kc/s in an audio system, and at these frequencies the effect of extra capacitance in all parts of the switch cannot be neglected. Due to imperfections in the driving waveform and stray capacity at the output the edges of the square wave will in fact occupy a finite time and although use of a double switch makes the edges more nearly symmetrical, the finite slopes of the edges will cause a certain amount of curvature of the modified non-linearity, mainly at the ends of the linear range, since it is there that the output wave will depart most from the ideal. The time occupied by the change over from one state to the other will have a further effect since during this time the product of voltage and current in the switching transistors is not zero. The power dissipated in the switching transistors will therefore increase as the proportion of the total time occupied by the edges of the square wave is increased. It is apparently most important therefore to ensure that the edges of the square wave occupy only a very small portion of the duration of the square wave, in order to keep both distortion and power dissipation to a low level. The actual power dissipated in each output transistor is calculated in Appendix 2.

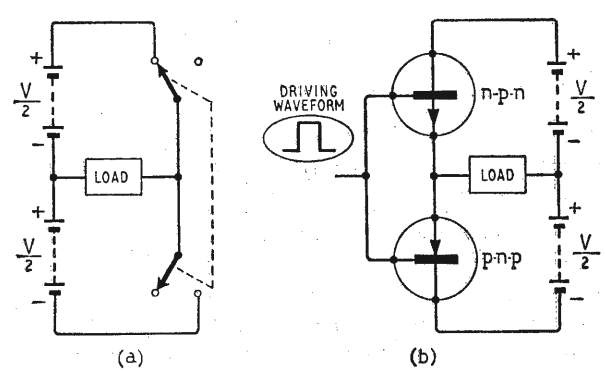
Amplifier Design

In order to ascertain the potentialities of the on-off type of audio system a small, low power system was constructed to the following specification:

(1). Power output 2 watts r.m.s. into a 15 ohm loudspeaker.
(2). Frequency response within $\pm$ 3dB from 50 c/s to 20 kc/s.
(3). Amplifier sensitivity such that 100mV r.m.s. input signal shall produce full output.
(4). Input impedance approximately 10kΩ.

The specification was chosen so that the system would be comparable with low power amplifiers of more con-

Fig. 3. (a) Double switch on-off system. (b) Practical implementation of (a) using two transistors.



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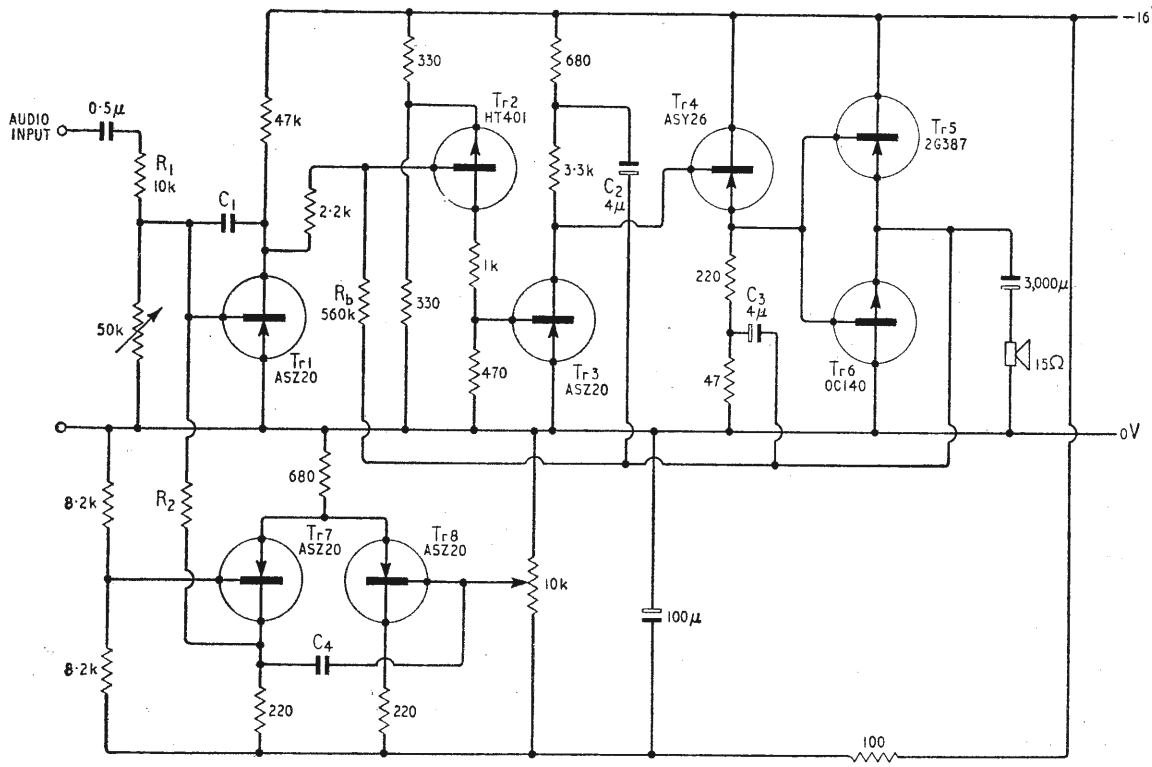

Fig. 4. Circuit diagram of the open-loop audio amplifier.

ventional design. Various aspects of the design procedure will now be considered.

Design of the Switch

Neglecting the bottoming potentials the maximum power in the loudspeaker (see Fig. 3(b)) will be given by

$$(P_o)_{max} = \frac{V^2}{8R}$$

so that the output square wave should have a pk—pk height of about 16V. Thus the supply to the system is fixed at 16V. The peak load current will then be approximately 0.5A, so that the output switching transistors must be capable of handling this current. With the arrangement of Fig. 3(b) it is necessary to ensure that sufficient base current can be provided to hold the output transistors sufficiently well bottomed. The switch is shown in Fig. 4. In order that the triangle generator (Tr1) shall not be heavily loaded, the switch is made up of three current gain stages (Tr2, Tr4 and Tr5/Tr6) and one stage of voltage gain (Tr3). Positive feedback is provided of a magnitude just sufficient to ensure that the switch has only two states, thus keeping the hysteretic width of the switch characteristic to a minimum.

Tr5 and Tr6, the output switching transistors, are driven from the emitter follower transistor Tr4 which has one of its emitter resistors bootstrapped *via* C_3 to enable it to hold Tr6 fully bottomed during the positive half of the square wave. C_3 must be large enough to provide an almost constant potential during the period that Tr6 remains bottomed, and the emitter resistor is chosen so that it can supply the necessary base current to hold Tr6 bottomed whilst the collector current of Tr6 is 500mA. Tr4 is driven from a positive gain amplifier Tr2/Tr3 which has a load resistor bootstrapped by C_2 to ensure that Tr4 and Tr5 are well bottomed during the negative half cycle of the square wave. The positive feedback is taken *via* the resistor R_b to the base of Tr2 from the output. In the design R_1 is set to 560kΩ. Values larger than this give a region of continuous variation in output potential which during normal operation will only slow the edges of the output square wave and possibly the subsequent increase in power could be tolerated. Even so this is surely to be avoided if possible and furthermore, under freak conditions (e.g., removal of the triangle), the output could attain potentials between the two supply lines with probable excessive dissipation in the output stage.

Switching Waveform Generator

The triangular switching waveform is obtained by integrating a square wave, which is obtained from a multivibrator circuit. The minimum permissible oscillation frequency of the switch is about 50 kc/s and the actual one used is 100 kc/s. An emitter-coupled multivibrator produces a good square wave at this frequency provided the transistors are not allowed to bottom. The multivibrator comprises transistors Tr7 and Tr8 (Fig. 4) and Tr1 is connected as a feedback summing integrator. The frequency of the square wave is set by varying C_4, and the 10kΩ potentiometer on the base of Tr8 is used to adjust the shape of the square waves at the collectors to be symmetrical, that is to have a mark to space ratio of

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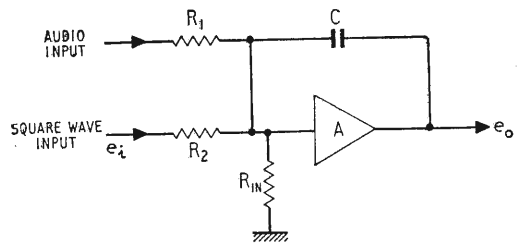


Fig. 5. Circuit of summing integrator with imperfect amplifier.

unity. Referring to Fig. 5, the transfer function of an amplifier of gain A, with input impedance R_{in}, connected as an integrator, is:-

$$\frac{e_o}{e_i} = \frac{R_c.A}{R_2} \cdot \frac{1}{1+pCR_c(1+A)},$$

where R_c is the parallel resistance of R_1, R_{in} and R_2. To obtain this transfer function it is necessary to consider the audio input point to be earthed (since the audio signal is normally derived from a low impedance source).

This equation may now be used in the design of the integrator. Before this can be done, however, it is necessary to decide on the distribution of the gain between the integrator and the modified switch. The overall audio voltage gain required is about sixty times. If it is attempted to obtain all this gain from the modified switch, then even a very small hysteretic width can restrict the extent of the linear region quite appreciably, and in addition the effect of a small drift in the output stages of the switching circuit will cause the operating point of the modified non-linearity to move from the centre of the linear region by a large amount, this obviously being undesirable. If the gain of the modified non-linearity is set to be approximately 3 then with the value of hysteresis chosen the linear region extends over almost the whole range of possible mean levels of the output, and at the same time drift effects are reduced. Having decided upon the gain through the switch to the audio signal the pk—pk height of the triangle must be $16/3 \approx 5$ V and the integrator must have an output swing capable of accommodating this size of triangle. The emitter of Tr2 is held at the mid-point of the supply by a low impedance resistance chain, and since the switch has only a very small hysteresis the mid-point of the triangle, and thus the mean level of the collector of Tr1 will be at this potential. Under conditions of peak drive, the triangle will not intersect with the switch operating point and thus the integrator must be capable of accommodating a swing of ± 5 V at the output.

As previously stated, the integrator transistor is used for the dual purpose of generating the triangular waveform, and adding the audio waveform to it. The input resistor (R_1) for the audio signal is a 10kΩ resistor to obtain the required input impedance. If we make the collector current in Tr1 when the collector potential is at the centre of the supply, about 200 μA, this will allow sufficient current to charge the feedback capacitor and operate the switch, and at the same time give an input impedance at the base of Tr1 of about 10kΩ. In the equation for the transfer function of the integrator to the audio signal (obtained by replacing R_2 by R_1 in the previous equation) we therefore have:—

$R_c \approx 5$kΩ and $R_1 = 10$kΩ (assuming $R_2 >> 5$kΩ)

The measured value of A was found to be approximately 40, so that the d.c. gain through the integrator will be about 20 to both the triangle and the audio signal. The gain to the audio signal will remain within 3dB of the d.c. gain up to a frequency given by:—

$$f = \frac{1}{2\pi R_c C_1(1+A)}$$

this frequency must be greater than at least 20kc/s. Substitution of the above values leads to a maximum value for C_1 of approximately 25pF. With this value of feedback capacity and with $R_2 = 27$kΩ the square wave required to produce a triangle of 5 V pk—pk is about 0.7 V pk—pk. R_2 must not be made too large since this will reduce the gain of the integrator as far as the square wave is concerned. This will cause exponential curvature of the triangles and consequent distortion of the modified non-linear characteristic. With R_2 set to 27kΩ, the square wave height is adjusted by variation of the collector resistors of Tr7 and Tr8 to obtain the 5 V pk—pk of the triangular waveform at the integrator output.

Test of the System

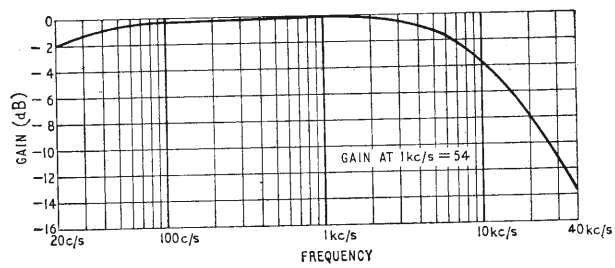
The system constructed according to the above design procedure was tested for frequency response and distortion. The frequency response curve is shown in Fig. 6 and the distortion terms at certain points in the system are given in Table 1. Both frequency response and distortion were measured at an output swing of 2 V r.m.s. across a simulated loudspeaker load of 15Ω and 5 mH in series. The low frequency fall-off in frequency response is due to the coupling capacitor on the input, and can be varied to suit particular requirements. The high frequency fall-off is wholly due to the integrator, since it was found that the integrator frequency response and the overall frequency response were identical in shape. The combined effect of the feedback capacitor, the miller capacitance of the transistor and stray capacitance, has apparently doubled the effective integrator time constant since the 3dB point is at 9kc/s rather than the 20kc/s designed for.

The distortion figures show that a large part of the

TABLE I
Distortion in open-loop amplifier at 2V r.m.s. across loudspeaker

POINT IN SYSTEM	f (=1kc/s.)	2f	3f	4f
Input	40mV (0dB)	−52dB	−54dB	>−60dB
Integrator Output	0.7V (0dB)	−34dB	−50dB	>−60dB
Loudspeaker	2V (0dB)	−31dB	−40dB	>−60dB
	f (=10kc/s.)	2f	3f	4f
Input	60mV (0dB)	−52dB	−52dB	>−60dB
Integrator Output	0.7V (0dB)	−33dB	−50dB	>−60dB
Loudspeaker	2V (0dB)	−36dB	−50dB	>−60dB

Fig. 6. Amplitude—frequency response of open-loop amplifier.



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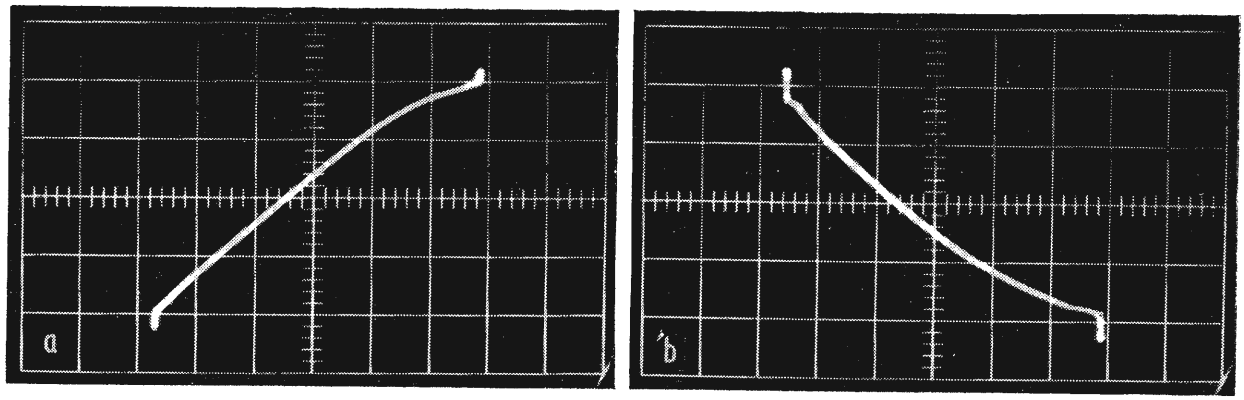


Fig. 7. Characteristics of open-loop amplifier. (a) Relay input v. relay output. (Input 1V/cm, output 2V/cm.) (b) Overall input v. output characteristic. (Input 50mV/cm, output 2V/cm.)

distortion of the amplifier occurs in the integrator stage. This must be due to the large swings which are required at the integrator output.

The input *versus* output characteristics of various parts of the system were displayed on an oscilloscope and photographed; these are shown in Fig. 7. The curvature of the input-output characteristic for the switch shows that there is significant distortion through this element as well as through the integrator.

Since the system functions as a modulator, sidebands will be produced. For large audio inputs at high frequencies these sidebands can be quite large and, more important, they can be frequencies which are in the audio spectrum and can thus be heard as unwanted high frequency outputs. In the system tested with large input signals at 10 kc/s these sidebands could both be heard and measured with a wave analyser and were found to be rather obtrusive.

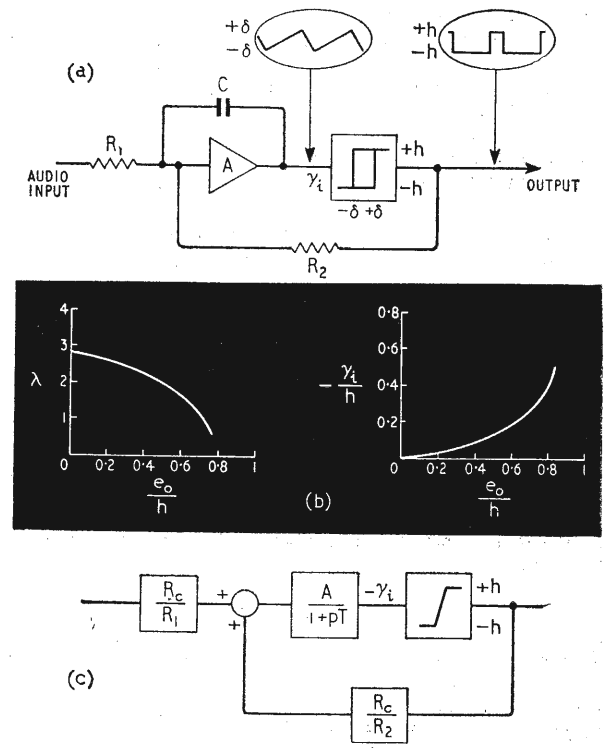
The system so far described has a performance which is rather mediocre, particularly in respect of its distortion figures. It does, however, have the main advantages of on-off systems in general, notably low power dissipation. However, it is a relatively complex system since to produce the switching waveform a square wave generator must be built. This generator has no function as far as the audio signal is concerned. A further disadvantage found in practice during tests on the system was that the operating point tended to move by quite large amounts away from the centre of the linear region. This effect is caused by relative drift between the operating point of the switch and the mean level of the triangle. It produces undesirable asymmetrical limitation of the output swing and increased distortion.

Various means may be employed to improve the system performance. The distortion can be reduced by improving the integrator design. This will improve the shape of the triangular waveform and thus improve the linearity of the modified switch characteristic, whilst at the same time it will possibly reduce the distortion through the integrator to the audio signal. The improved integrator will almost certainly require extra transistors.

The audio signal could be applied direct to the switch, thus eliminating one source of distortion from the audio path. This would waste potential audio gain and further increase the complexity of the system since additional amplifying stages would then be required to obtain the desired audio gain.

Without increasing the complexity of the system, the only alternative seems to be to attempt to reduce the triangle size, possibly even to the point where the audio signal can be applied directly to the switch. To maintain the same gain would require a triangle height of 260mV pk—pk. This would require that both the relative drift and the hysteretic width be well below this figure. These extremely stringent conditions mean that the optimum design for the present configuration and the specification

Fig. 8. Characteristics of an oscillating loop. (a) Block diagram of the loop. (b) Oscillation frequency of the loop and the d.c. input to the switch as function of the mean level of the output. (c) Low frequency equivalent circuit of the loop.



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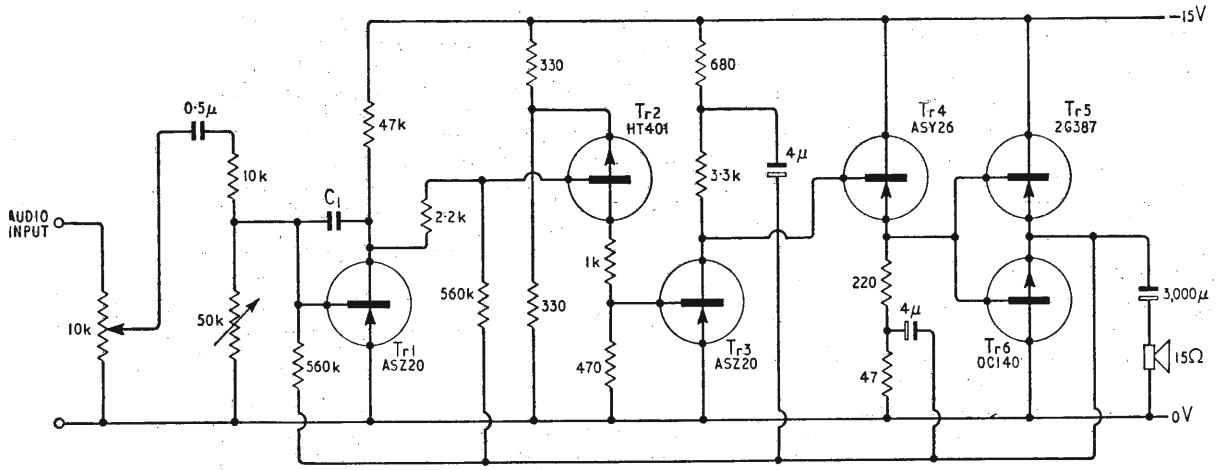

Fig. 9. Circuit diagram of the closed-loop on-off audio amplifier.

adopted is probably somewhere between this solution and the system described.

The square wave generator could be dispensed with altogether merely by connecting the loudspeaker driving point (i.e. the emitters of Tr5 and Tr6) to the integrator input base by a resistor. This causes a negative feedback oscillation to be set up due to the phase shift around the loop, resulting in a square wave oscillation across the loudspeaker, whose mean level is controlled by the audio input signal in such a way that the average input signal into the integrator base is approximately zero. It is important to note that in this oscillating system there is inherent negative feedback to the audio signal. This has certain advantages just as feedback has advantages in more conventional systems. It can reduce distortion due to the amplifier, and it can increase the system bandwidth. The overall gain of the system is better defined and the requirements for ripple in a mains derived power supply are reduced. It reduces the output impedance of the amplifier, thus driving the loudspeaker from a low impedance source which is necessary to damp out loudspeaker resonances at low frequencies.

Theoretical Aspects of the Closed-loop System

As noted previously the closed loop system functions in a totally different way from the open loop system. The pk-pk height of the triangle is now constant at δ, and different values of the mark-space ratio of the output square wave are obtained by varying the slope of the sides of the triangle (see Fig. 8(a)). The limitations of the integrator performance will cause the triangle sides to be part of exponential curves, and will thus modify the effective input *versus* output curves for the switch. It is possible to analyse the closed loop system which is shown in Fig. 8(a).* The integrator here has the transfer function:—

$$\frac{e_o}{e_i} = \frac{K}{1+pT}.$$

The hysteretic width of the switch is 2δ and its two output levels are $\pm h$. For this system it is found that:—

$$\frac{2hK}{\delta} = \coth\frac{B}{\lambda} + \coth\frac{\pi-\beta}{\lambda}$$

$$\frac{\gamma_i \pi}{2hK} = \frac{\pi}{2}\left[1 - \frac{\sinh\frac{\pi-\beta}{\lambda}}{\sinh\frac{\pi}{\lambda}}\right]$$

where $\lambda = 2\pi T \times f_{osc}$ (f_{osc} being the oscillation frequency of the loop), γ_i is the switch d.c. input, i.e. the mean level of the switching waveform, and $\frac{\beta}{\pi-\beta} = \frac{T_1}{T_2}$ (comparing Fig. 8(a) and Fig. 1(b)). From these results it is possible to draw curves relating oscillation frequency and d.c. input to the switch (γ_i) with the mean level of the output. These are shown in Fig. 8(b) for the case when $K = 1$ and $\delta/h = \frac{1}{2}$. Examination of the curve for γ_i shows that the switch behaves as a gain of about 5 over a large region of the characteristic which has considerable curvature over its full range. The oscillation frequency can be seen to vary considerably over the full range of output. Both oscillation frequency and gain are dependent on the ratio of δ/h (being high when δ/h is small) and also on the integrator d.c. gain K. The bigger the value of K the higher the gain through the switch to the d.c. signal. (For $K = \infty$, γ_i is always zero.)

So far as the audio input and output are concerned, we may represent the system to that shown in Fig. 8(c) which is a feedback loop containing a saturating amplifier. The frequency response of a self-oscillating loop of this type can be calculated although the calculation is laborious. Theoretical results indicate that the frequency response is almost flat up to about one half of the oscillation frequency provided that the gain K is large.

Design Details of the Closed-loop System

The main elements of the closed loop system, notably the switch and the integrator are common to both systems, and in order to allow a fair comparison to be made between the two systems, the same switch and the same integrator were used as for the open loop system, the only difference is that the square wave from the

*"A Method for the Theoretical Analysis of Relay Amplifiers." G. F. Turnbull, D. P. Atherton and J. M. Townsend, to be published in *Proc. I.E.E.*

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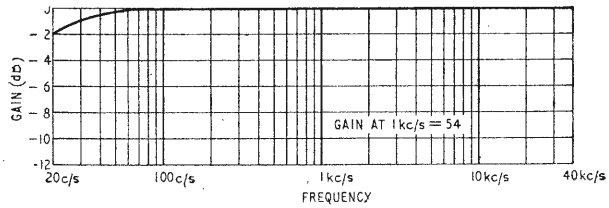

Fig. 10. Amplitude—frequency response of closed-loop amplifier.

output is taken to the integrator *via* a 560kΩ resistor. This defines the gain to the audio signal as 560/10 = 56. The feedback capacitor round the integrator was adjusted to make the oscillation frequency when $T_1 = T_2$ about 100 kc/s. With zero input signal the square wave was initially set to be symmetrical by adjustment of a 50kΩ potentiometer between base and emitter of the integrator transistor. The practical circuit is shown in Fig. 9.

Test of the Closed-Loop System

The closed loop system described was tested in the same way as the open-loop system described previously, and the results are shown in Fig. 10 and Table 2. One factor immediately apparent from Fig. 10 is that the

TABLE 2
Distortion in closed-loop amplifier at 2V r.m.s. across loudspeaker

POINT IN SYSTEM	f (=1kc/s.)	2f	3f	4f
Input	40mV (0dB)	−52dB	−54dB	>−60dB
Loudspeaker	2V (0dB)	−40dB	−52dB	−50dB
	f (=10kc/s.)	2f	3f	4f
Input	40mV (0dB)	−52dB	−54dB	>−60dB
Loudspeaker	2V (0dB)	−40dB	−52dB	−50dB

frequency response of the closed-loop system is rather better than that of the open loop system, in spite of the fact that the integrator capacitor was about five times as large in the closed-loop system as it was in the open-loop system. Comparison between Table 1 and Table 2 also shows that the overall distortion is very much reduced in the closed-loop case. Photographs of the overall input *versus* output and switch input *versus* output characteristics of the amplifier were taken and are shown in Fig. 11. The effect of the feedback in improving the distortion in a non-linear system is clearly seen. Measurement of the signals at the input and output of the switch indicated that the gain through the switch to small signals was about 200, thus giving a low frequency open-loop gain of about 75 (the integrator d.c. gain (A) being about 40, as before). Fig. 12(a) shows the shape of the switching waveform and the output waveform from the switch in the closed-loop amplifier. Fig. 12(b) shows the same waveforms in the open-loop

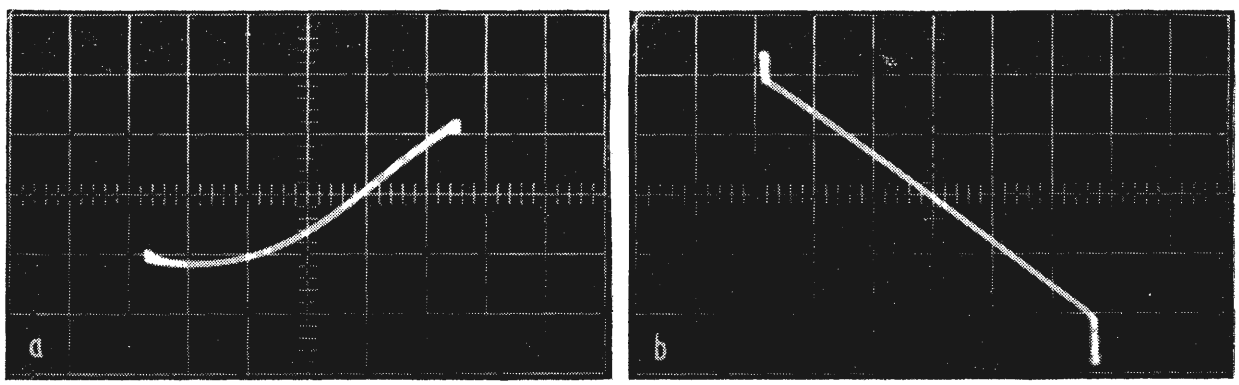

Fig. 11. Characteristics of the closed-loop amplifier. (a) Relay input v. relay output. (Input 50mV/cm, output 2V/cm.) (b) Overall input v. output. (Input 50mV/cm, output 2V/cm.)

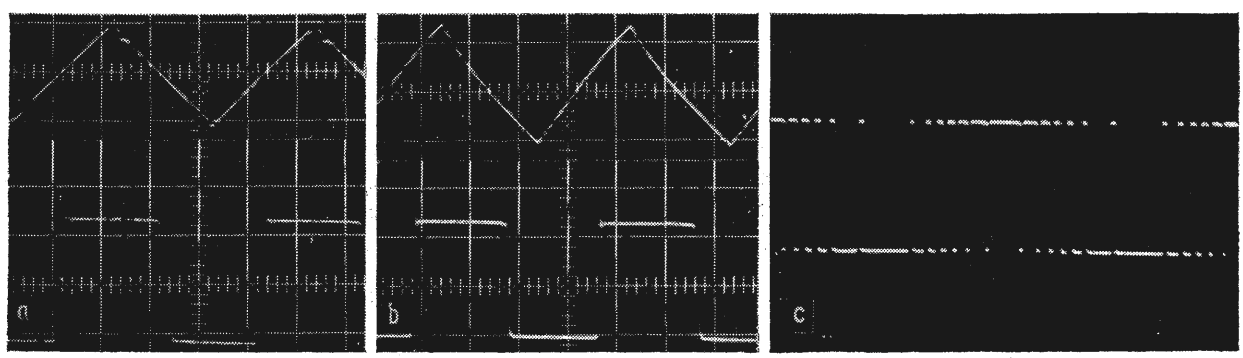

Fig. 12. (a) Switching and output waveforms in the closed-loop amplifier. (Top 100mV/cm, 2μsec/cm; bottom 5V/cm, 2μsec/cm.) (b) Switching and output waveforms in the open-loop amplifier. (Top 2V/cm, 5μsec/cm; bottom 5V/cm, 5μsec/cm.) (c) Loudspeaker driving waveform for closed-loop amplifier driven with 6 kc/s signal.

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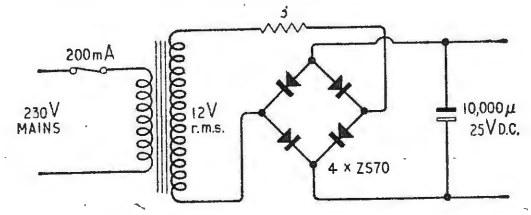

Fig. 13. Mains power supply.

amplifier, and Fig. 12(c) is included since it illustrates the principle of operation of the on-off type of system, being a photograph of the output waveform as a function of time when the system is modulated by a sinusoidal signal.

The sideband components at the output of the system mentioned earlier in the tests on the open-loop amplifier represent spurious signals. These should be reduced by the negative feedback over the audio region when the negative feedback is operative. It was found during tests that this was indeed the case; over the audio range there was almost complete suppression of these unwanted signals.

The frequency change measured in the amplifier as a function of mean output level was very close to that theoretically predicted for the case when $K=\infty$ which is

$$\lambda=\lambda_0\left[1-\left(\frac{e_0}{h}\right)^2\right]$$

where λ_0 is the maximum oscillation frequency, so that the frequency change over the working range of the amplifier is not so great as is suggested by Fig. 8(b)."

Conclusions

Two types of on-off audio amplifier have been described and the performance of the two systems using the same principal components has been compared in a way which was considered to be the most fair to both systems. Whilst it is obviously possible to construct an open-loop system to give an extremely good performance it would appear that a closed-loop system can be made to give the same performance with every much less complexity, and thus at a lower cost. In the systems described every attempt was made to use transistors of minimum cost throughout and no transistor used cost more than ten shillings.

The output power achieved in the circuits described may be considered rather low. The decision to keep to a low power circuit was taken because it was desired to achieve small size and low cost, and there appears to be a dearth of cheap transistors in small cans which will handle collector currents of greater than 500mA, particularly in the npn category. Higher output can, however, be obtained by uprating everything in the circuit, once suitable output transistors have been obtained. An alternative solution would be to use parallel operation of the output transistors. It would be advisable under these circumstances to include a small resistor in each emitter lead to ensure equal current sharing between the transistors. It is also possible to use four transistors in a bridge circuit for the output stage, with an increase of a factor of four in the power output for a given supply This system has the disadvantage that the loudspeaker is " floating " relative to the supply so that it is extremely difficult to employ the circuit in a closed loop system. It also uses twice as many transistors in the output stage since the current rating of the transistors still needs to be

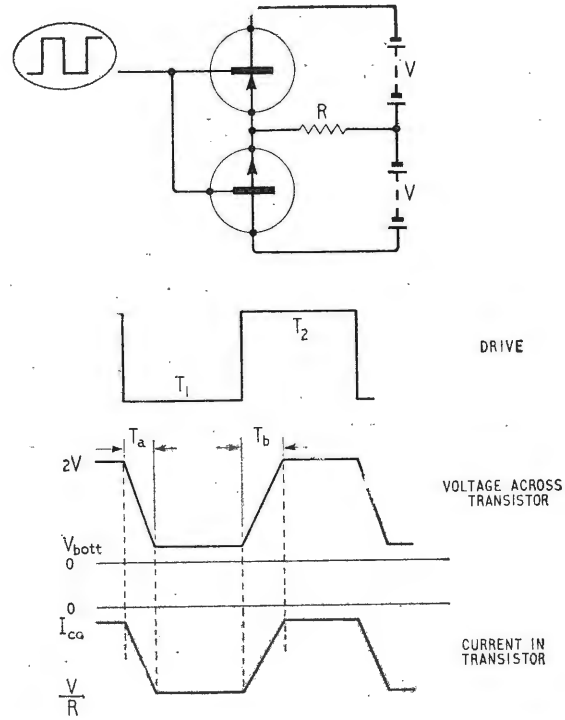

Fig. 14. Approximate conditions in the output stage during change of state.

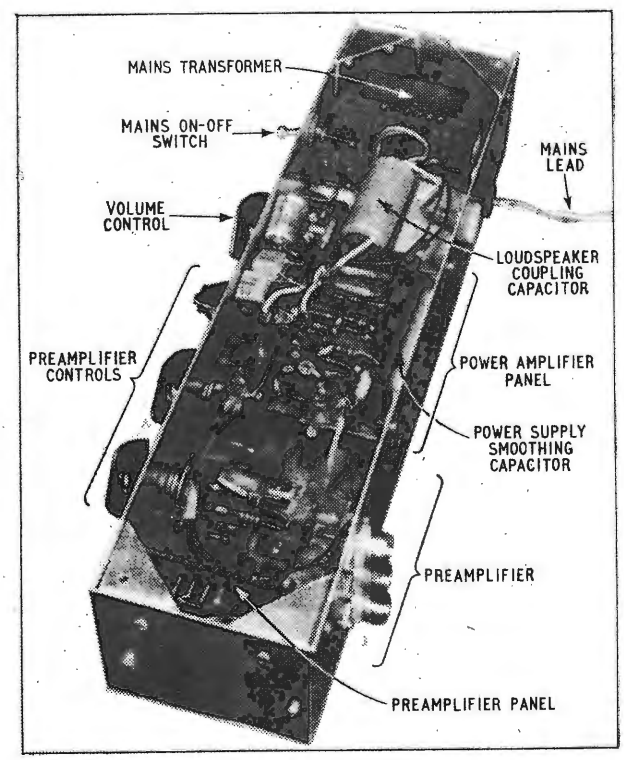

Fig. 15. Closed-loop amplifier with pre-amplifier and power supply.

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the same as in the case when the supply voltage is doubled, to obtain the higher power output.

One disadvantage of on-off systems running at 100 kc/s which is brought out by practical tests is that of radiation. The circuit whether open or closed loop, is a prolific source of radiated harmonics and this is a serious disadvantage if it is to be driven from a medium wave tuner. Radiation can, however, be reduced very greatly by screening the amplifier. No interference has been caused to neighbouring equipment working in anything but the long and medium wave bands, and the field of radiation from an enclosed system does not appear to extend more than a few feet.

Comments on the actual power efficiency are contained in Appendix 2.

Power Supply

The circuit of a mains power supply suitable for driving the amplifier is shown in Fig. 13. The value of the smoothing condenser is large enough to give a hum level at the output of the amplifier which is about −80dB relative to full output. There is insufficient smoothing to give a satisfactory hum level in the open-loop amplifier.

Fig. 15 shows a photograph of the prototype closed-loop audio system with an input pre-amplifier equalised for f.m. radio, l.p. and standard play recordings, etc. The system is sensitive enough to be driven from a magnetodynamic pick-up. The whole system including the mains power supply is contained in an aluminium box 11in. × 3in. × 2in., and the majority of the space in the box is taken up by the potentiometers and the 10,000μF smoothing condenser in the power supply.

APPENDIX 1

Calculation of the Modified Switch Characteristic

Referring to Fig. 2, assume that the triangular switching waveform is displaced to the right by an amount γ_i This corresponds to the situation which occurs in the open-loop system (Fig. 1 (c)) when the audio input signal has an instantaneous value $+\gamma_i$.

Denoting T_2 in Fig. 1 (b) by $T_2 = t_2 - t_1$, where t_2 and t_1 are the times at which the switch operates measured from the zero on the triangle in Fig. 4:—

$$t_1 = \pi + \frac{\pi}{\Delta}(\gamma_i + \delta)$$

$$t_2 = 2\pi - \frac{\pi}{\Delta}(\gamma - {}_i\delta)$$

i.e. $$t_2 = \pi - \frac{2\pi}{\Delta}\gamma_i$$

Thus the mean level of the output is given by:—

$$e_o = h(\tfrac{1}{2} + \gamma_i/\Delta)$$

The characteristic e_o *versus* γ_i does not extend over the whole range from 0 to h, since some value of e_o are physically unrealizable because the triangle does not intersect with the relay operating point. This occurs when

$$|\gamma_i + \delta| \geqslant \frac{\Delta}{2}$$

The limiting values on the characteristic are thus

$$e_o = h(1 - \frac{\delta}{\Delta})$$

and $$e_o = h(\frac{\delta}{\Delta})$$

The fraction of the total characteristic actually covered by the linear region is $\left(1 - \frac{2\delta}{\Delta}\right)$, and the gain in the linear region of the modified characteristic is h/Δ.

With the values used in the open-loop system described (i.e. h = 16 volts) Δ = 5 volts and δ = 100 mV) the percentage of the range covered is $100\left[1 - \frac{200}{5000}\right] = 96\%$ and the gain is 16/5 = 3.4.

APPENDIX 2

Calculation of the Power Dissipation in the Output Transistors

Referring to Fig. 14, the power (P) dissipated in each output transistor is obtained by considering each of the four regions in turn, each region being integrated separately.

$$P = \frac{1}{T}\int_0^T V.I\,dt$$

$$\therefore P = \frac{1}{T_1+T_2}\left[\int_0^{T_a}\left[2V - (2V-V_{bott})\frac{t}{T_a}\right]\frac{V.t}{RT_a}dt + \int_0^{T_1-T_a} V_{bott}\cdot\frac{V}{R}dt + \int_0^{T_b}\left[V_{bott} + (2V-V_{bott})\frac{t}{T_b}\right]\left[\frac{V}{R} - \frac{Vt}{RT_b}\right]dt + \int_0^{T_2-T_b} 2V\,I_{co}\,dt\right]$$

Thus the total power in each transistor is

$$P = \frac{1}{T_1+T_2}\left[\frac{VV_{bott}(3T_1 - 2T_a + T_b) + V^2(T_a + T_b) + 6RVI_{co}(T_2 - T_b)}{3R}\right]$$

In the design described,

$T_1 + T_2 = 7.5\ \mu$sec.
$T_a = 0.4\ \mu$sec, $T_b = 0.5\ \mu$sec.
$V_{bott} = 0.3$V, $I_{co} = 1$mA (maximum)
$V = 8$V, $R = 15$ ohms

giving P approximately 250 mW in each transistor.

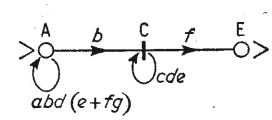
This gives an efficiency of $\frac{200}{2.5} = 80\%$. If the oscillation frequency were reduced to 50 kc/s, making $(T_1+T_2) = 20\ \mu$sec. then this increases the efficiency to almost 90%. With this frequency of oscillation the frequency response of the closed loop system is still very good. The use of higher frequency transistors can, of course, increase the efficiency even more.

"Signal Flow Diagrams"

In W. Grant's article in the February issue, the mathematical working in Theorem 2g.1 (page 96) should end as

$$C = \frac{ac + b}{1 - cd}$$

Also, the right-hand diagram in Example 3d.2 (page 97) is incorrectly annotated. It should be:



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MATRIX ALGEBRA

2. – ITS APPLICATION TO CIRCUIT ANALYSIS

By G. H. OLSEN,* B.Sc. A.M.I.E.R.E.

READERS of last month's article on matrix algebra will recall that many arrangements of linear components may be regarded as four-terminal networks such networks being represented by a "black-box" as in Fig. 1.

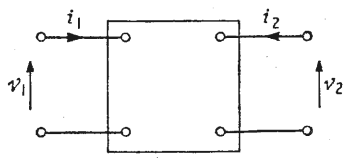

Fig. 1

With circuit arrangements that can be reduced to two-terminal networks we find it very convenient to describe such a network by the simple expression R + jX. Unfortunately such a simple expression is inadequate for four-terminal networks because of the increased number of variables involved. However, we saw that a two-by-two matrix is a sufficiently simple and adequate expression to describe four-terminal networks, the elements of such a matrix giving valuable information about the network's behaviour.

The four independent variables v_1, i_1, v_2, i_2 may give rise to six different ways of describing the external behaviour of the network. For our purpose we need only consider four of these ways.

The first, discussed in detail in the previous article may be expressed by the two equations :—

$$v_1 = a_{11} v_2 - a_{12} i_2 \quad \ldots \quad (1)$$

$$i_1 = a_{21} v_2 - a_{22} i_2 \quad \ldots \quad (2)$$

which in matrix form reduces to :—

$$\begin{pmatrix} v_1 \\ i_1 \end{pmatrix} = [A] \begin{pmatrix} v_2 \\ -i_2 \end{pmatrix}$$

The elements of the A-matrix describe the particular network involved; and by applying certain rules we saw how combinations of networks in cascade could be described by a single matrix, the latter being obtained by multiplying together the individual matrices of the networks making up the combination (see Fig. 2).

The transfer function of the composite network was one of the most valuable items of information obtained from a consideration of the elements of [A].

Circuits are not always, however, made up of networks connected in cascade as above. We may have networks connected in parallel (e.g. the parallel-T filter) or in series at their inputs and outputs; or we may have the inputs in series and the outputs in parallel. In such cases the A-matrix may not be the best description available. Other matrices are possible and, especially for certain transistor work, these alternatives have distinct advantages over the A-matrix. For those readers who are just starting on transistor work it is hoped that this article will show how some of the parameters associated with transistors arise; and perhaps they will then take some comfort in the fact that some order does indeed exist among the bewildering number of parameters that can be used.

The A-matrix and other matrices are all obtained by using one central idea or theme. From the quantities v_1, i_1, v_2, i_2 in Fig. 1 we may regard any pair as known and the other pair as unknown. With v_2 and i_2 known, v_1 and i_1 can be expressed as in equations (1) and (2). From these equations the A-matrix is defined. Similarly the following matrices may be obtained:

$$i_1 = y_{11} v_1 + y_{12} v_2 \quad \ldots \quad (3)$$

$$i_2 = y_{21} v_1 + y_{22} v_2 \quad \ldots \quad (4)$$

which in matrix form is

$$\begin{pmatrix} i_1 \\ i_2 \end{pmatrix} = \begin{pmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{pmatrix} \begin{pmatrix} v_1 \\ v_2 \end{pmatrix} = [Y] \begin{pmatrix} v_1 \\ v_2 \end{pmatrix} \quad \ldots \quad (5)$$

The elements of the y-matrix are known as the y-parameters since each has the dimensions of an admittance. The matrices are particularly useful when analysing circuits consisting of two networks in parallel at their input and output terminals (Fig. 3).

The overall matrix is given by $[Y] = [Y_1] + [Y_2]$ i.e. the elements in corresponding positions in $[Y_1]$ and $[Y_2]$ are merely added. An example of an analysis using this technique is given later.

If we take as our starting point

$$v_1 = z_{11} i_1 + z_{12} i_2 \quad \ldots \quad (6)$$

$$v_2 = z_{21} i_1 + z_{22} i_2 \quad \ldots \quad (7)$$

which in matrix form is

$$\begin{pmatrix} v_1 \\ v_2 \end{pmatrix} = \begin{pmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{pmatrix} \begin{pmatrix} i_1 \\ i_2 \end{pmatrix} = [Z] \begin{pmatrix} i_1 \\ i_2 \end{pmatrix} \quad \ldots$$

we obtain the z-matrix for the network. The z-matrices are most useful in the analysis of networks arranged in series as in Figure 4.

The overall matrix is given by $[Z] = [Z_1] + [Z_2]$

The individual elements of a z-matrix all have the dimensions of an impedance.

The last matrix we need consider is the h-matrix. It is this matrix that is most useful when considering transistors. The individual elements of this matrix are the

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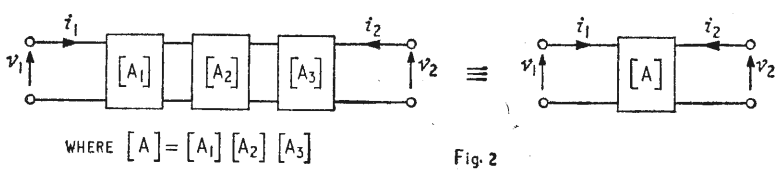

Fig. 2

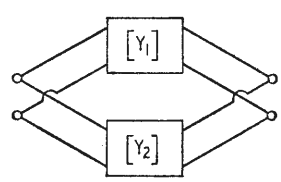

Fig. 3

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hybrid or h-parameters often quoted by manufacturers of transistors. The matrix is defined from the following equations:—

$$v_1 = h_{11}\, i_1 + h_{12}\, v_2 \quad \ldots \quad (8)$$

$$i_2 = h_{21}\, i_1 + h_{22}\, v_2 \quad \ldots \quad (9)$$

which in matrix form is:—

$$\begin{pmatrix} v_1 \\ i_2 \end{pmatrix} = \begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{pmatrix} \begin{pmatrix} i_1 \\ v_2 \end{pmatrix} = [H] \begin{pmatrix} i_1 \\ v_2 \end{pmatrix}$$

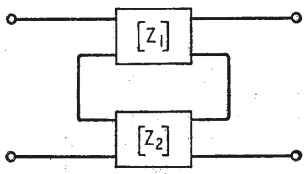

Fig. 4

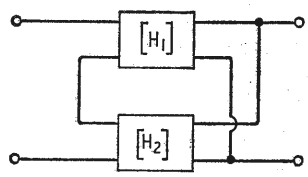

Fig. 5

In circuit analysis the h-matrices are most useful in the configuration of Fig. 5.

The overall h-matrix is given by $[H] = [H_1] + [H_2]$.

Consider now the transistor manufacturer's dilemma when wishing to publish design data on his products. The matrices described so far each have their advantages when applied to suitable circuit configurations; but from the manufacturer's point he wishes to describe his transistors with parameters that can easily be measured accurately and unfortunately the z- and y-parameters do not permit of easy determination because of the way in which they are defined. An examination of the h-parameters shows that they can all be determined easily

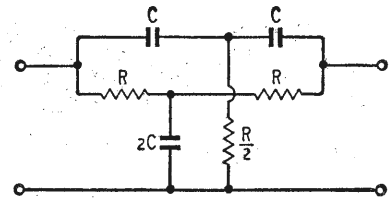

Fig. 6

and accurately. This is why the h-parameters are now widely used in manufacturers' data sheets, in textbooks and articles. D. N. Tilsley in the May 1964 issue of the *Wireless World* (p229) has described the parameters in detail and it is thus unnecessary to go over the same ground again. It is essential however to point out that it will be necessary to be able to convert the h-parameters into the corresponding z-, y- and A-parameters depending upon the particular circuit arrangement it is wished to examine. Since no one can rapidly convert one set into another from first principles every time a conversion is required it is usual to refer to a table. There is nothing complicated about the use of the tables. Like the log. tables with the trig. ratios etc., and the tables of Laplace transforms, the tables of matrix conversions should be readily available to all electronic engineers especially in examinations. Such a table is given in Table 1. Only one symbol used has not been defined so far, and that is the one used for the determinant of a matrix. Taking the A-matrix as an example we have

$$[A] = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \text{ and det. A (written } |A|) = a_{11}a_{22} - a_{12}a_{21}.$$

Applications

When using matrices in circuit analysis we must first determine the most useful matrix form to use. As an example let us take the case of the parallel twin- T network shown in Figure 6.

To obtain the overall matrix of this configuration we

TABLE 1

CONVERSION FROM	To			
A-Matrix parameters	$z_{11} = \frac{a_{11}}{a_{21}}$ $z_{12} = \frac{\lvert A\rvert}{a_{21}}$ $z_{21} = \frac{1}{a_{21}}$ $z_{22} = \frac{a_{22}}{a_{21}}$	$y_{11} = \frac{a_{22}}{a_{12}}$ $y_{12} = \frac{-\lvert A\rvert}{a_{12}}$ $y_{21} = \frac{-1}{a_{12}}$ $y_{22} = \frac{a_{11}}{a_{12}}$	$h_{11} = \frac{a_{12}}{a_{22}}$ $h_{12} = \frac{\lvert A\rvert}{a_{22}}$ $h_{21} = \frac{-1}{a_{22}}$ $h_{22} = \frac{a_{21}}{a_{22}}$	$\lvert A\rvert = a_{11}a_{22} - a_{12}a_{21}$
z-parameters	$a_{11} = \frac{z_{11}}{z_{21}}$ $a_{12} = \frac{\lvert z\rvert}{z_{21}}$ $a_{21} = \frac{1}{z_{21}}$ $a_{22} = \frac{z_{22}}{z_{21}}$	$y_{11} = \frac{z_{22}}{\lvert z\rvert}$ $y_{12} = \frac{-z_{12}}{\lvert z\rvert}$ $y_{21} = \frac{-z_{21}}{\lvert z\rvert}$ $y_{22} = \frac{z_{11}}{\lvert z\rvert}$	$h_{11} = \frac{\lvert z\rvert}{z_{22}}$ $h_{12} = \frac{z_{12}}{z_{22}}$ $h_{21} = \frac{-z_{21}}{z_{22}}$ $h_{22} = \frac{1}{z_{22}}$	$\lvert z\rvert = z_{11}z_{22} - z_{12}z_{21}$
y-parameters	$z_{11} = \frac{y_{22}}{\lvert y\rvert}$ $z_{12} = \frac{-y_{12}}{\lvert y\rvert}$ $z_{12} = \frac{-y_{21}}{\lvert y\rvert}$ $z_{22} = \frac{y_{11}}{\lvert y\rvert}$	$a_{11} = \frac{-y_{22}}{y_{21}}$ $a_{12} = \frac{-1}{y_{21}}$ $a_{21} = \frac{-\lvert y\rvert}{y_{21}}$ $a_{22} = \frac{-y_{11}}{y_{21}}$	$h_{11} = \frac{1}{y_{11}}$ $h_{12} = \frac{-y_{12}}{z_{11}}$ $h_{21} = \frac{y_{21}}{y_{11}}$ $h_{22} = \frac{\lvert y\rvert}{y_{11}}$	$\lvert y\rvert = y_{11}y_{22} - y_{12}y_{21}$
h-parameters	$z_{11} = \frac{\lvert h\rvert}{h_{22}}$ $z_{12} = \frac{h_{12}}{h_{22}}$ $z_{21} = \frac{-h_{21}}{h_{22}}$ $z_{22} = \frac{1}{h_{22}}$	$y_{11} = \frac{1}{h_{11}}$ $y_{12} = \frac{-h_{12}}{h_{11}}$ $y_{21} = \frac{h_{21}}{h_{11}}$ $y_{22} = \frac{\lvert h\rvert}{h_{11}}$	$a_{11} = \frac{-\lvert h\rvert}{h_{21}}$ $a_{12} = \frac{-h_{11}}{h_{21}}$ $a_{21} = \frac{-h_{22}}{h_{21}}$ $a_{22} = \frac{-1}{h_{21}}$	$\lvert h\rvert = h_{11}h_{22} - h_{12}h_{21}$

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first note that two T-networks are connected in parallel at their input and output terminals. The y-parameters are therefore used since simple addition of the y-elements for each T-network gives us the overall y-matrix. If only the A-matrix parameters are known we would proceed as follows:—

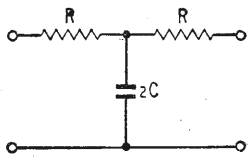


Fig. 7

The A-matrix of the T-network can be found from the individual matrices of the components as shown in the last article. The result (see Fig. 7) is given by

$$[A_1] = \begin{pmatrix} 1 + 2j\omega CR & 2R + 2j\omega CR^2 \\ 2j\omega C & 1 + 2j\omega CR \end{pmatrix} = \begin{pmatrix} \alpha & \beta \\ \gamma & \alpha \end{pmatrix} \text{ say.}$$

(It should be noted in passing that $|A| = 1$, a property of the A-matrices of passive linear symmetrical networks). Using the conversion table

$$[Y_1] = \begin{pmatrix} \frac{\alpha}{\beta} & -\frac{1}{\beta} \\ -\frac{1}{\beta} & \frac{\alpha}{\beta} \end{pmatrix}$$

Similarly the A-matrix of the network of Fig. 8 is given by

$$A_2 = \begin{pmatrix} 1 + ZG & 2Z + Z^2G \\ G & 1 + ZG \end{pmatrix} \quad \text{where } Z = \frac{1}{j\omega C}$$

$$\text{and } G = 2/R$$

$$= \begin{pmatrix} \alpha' & \beta' \\ \gamma' & \alpha' \end{pmatrix}$$

Thus

$$[Y_2] = \begin{pmatrix} \alpha'/\beta' & -1/\beta' \\ -1/\beta' & \alpha'/\beta' \end{pmatrix}$$

The overall y-matrix for the parallel T-network is therefore

$$[Y_3] = \begin{pmatrix} \frac{\alpha}{\beta} + \frac{\alpha'}{\beta'} & -\left(\frac{1}{\beta} + \frac{1}{\beta'}\right) \\ -\left(\frac{1}{\beta} + \frac{1}{\beta'}\right) & \left(\frac{\alpha}{\beta} + \frac{\alpha'}{\beta'}\right) \end{pmatrix}$$

From Eqn. (3) + (4) the transfer function is $-y_{21}/y_{22}$ i.e. $(\beta + \beta')/(\alpha\beta' + \alpha'\beta)$. For infinite attenuation $\beta + \beta' = 0$.

This occurs when $\omega = \omega_0$ say.

$$\therefore 2R + 2j\omega_0 C R^2 + \frac{2}{j\omega_0 C} - \frac{2}{\omega_0^2 C^2 R} = 0$$

$$\therefore \omega_0 = \frac{1}{CR}$$

Infinite attenuation therefore results at a frequency $f_0 = 1/(2\pi CR)$.

Before looking at the application of matrix algebra to transistor circuit analysis let us consider the symbol conventions used since we need to be quite clear about the interpretation of any symbol. As the h-parameters appear in the conversion table they apply to transistors used in the grounded-base mode of operation. When considering the grounded-emitter mode the same expressions are used except that all the h's are primed thus, h'_{11}, h'_{12} etc. By considering the defining equations (8) and (9) we see that $h_{21} = \alpha$ (when $v_2 = 0$ i.e. the output is short circuited to a.c.); h_{21} is therefore the current gain in the grounded base mode of operation. $h'_{21} = \alpha' = \beta$ i.e. the current gain of a grounded-emitter transistor. We also have the conventional symbols described by D. N. Tilsley where $h'_{11} = h_{ie}$; $h'_{12} = h_{re}$; $h'_{21} = h_{fe}$ and $h'_{22} = h_{oe}$.

The matter of conventions is not yet settled and many writers still go by preference. This writer prefers the numeral subscripts since the position in the matrix requires no effort on the part of the memory; additionally, the letter subscripts refer to English words such as "forward" and "reverse" and these are not likely to be adopted by non-English-speaking countries.

With many important practical circuits we often need to know one or more of the following: input impedance, voltage gain, current gain, power gain and output impedance. All of this information is available in compact form when using matrices. Take as an easy example a straightforward transistor amplifier, Fig. 9(a) and its matrix equivalent, Fig. 9(b).

Regarding this as two four-terminal networks in cascade we find it convenient to use A-matrices. The overall A-matrix will give the information we need; but let us say that only the h-parameters are available from the manufacturer's data. We first convert the h-parameters to A-parameters, using the table; then multiply the matrix by that representing the load. The overall matrix [A] is given by

$$[A] = \begin{pmatrix} \frac{-|h'|}{h'_{21}} & \frac{-h'_{11}}{h'_{21}} \\ \frac{-h'_{22}}{h'_{21}} & \frac{-1}{h'_{21}} \end{pmatrix} \begin{pmatrix} 1 & 0 \\ G_L & 1 \end{pmatrix} \quad \text{where } G_L = \frac{1}{R_L}$$

The required information can then be easily extracted.

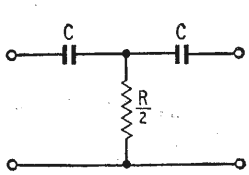
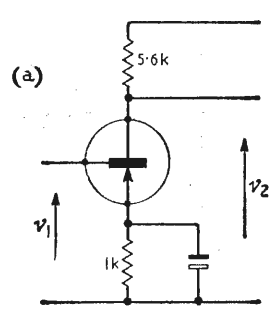
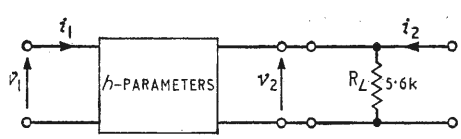


Fig. 8





(b)

Fig. 9

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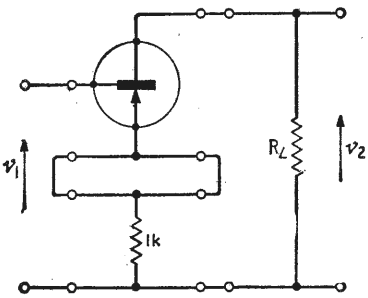

Fig. 10

For example the voltage gain will be given by the reciprocal of the a_{11} element of [A]

i.e. $\dfrac{-h'_{21}}{|h'| + Gh'_{11}}$

Suppose therefore that $h'_{11} = 1k\Omega$, $h'_{12} = 3 \times 10^{-4}$ $h'_{21} = 50$ and $h'_{22} = 50\mu\mho$ then $|h'| = 50 \times 10^{-3} - 150 \times 10^{-4} = 35 \times 10^{-3}$. The voltage gain is therefore $-50/(35 \times 10^{-3} + G_L \times 10^3)$. For a 5.6k load resistor the voltage gain is therefore 235. The input resistance is found from equations (1) and (2) to be a_{11}/a_{21} of [A] (i_2 being zero for the cascaded pair). This turns out to be

$$R_{in} = \frac{h'_{11} + |h'| R_L}{1 + h'_{22} R_L} = 930 \text{ (approx.)}$$

If feedback is introduced by omitting the by-pass capacitor across the emitter resistor (= 1kΩ say) we have Fig. 10 as a four-terminal equivalent.

The procedure here would be to notice that since the transistor and emitter resistor networks are in series at their inputs and outputs we require the z-parameters of each network. Addition gives the overall z-matrix which can then be converted to the A-matrix and multiplied by the A-matrix for the load resistor. It will be found that the intermediate working becomes rather cumbersome if symbols are retained so, if the configuration includes a transistor and emitter resistor with known parameters it is better to work out the numerical values of the matrix elements as one goes along. Once the overall A-matrix is obtained the voltage and current gains, and input and output impedances are readily determined. Provided the writer has done his homework satisfactorily readers should find that the gain is now ≈5.5 and the input resistance about 39kΩ.

Although matrix algebra is not the answer to every problem of circuit analysis, it is a powerful tool that ought to be more widely used. Criticism that precise formulations are a waste of time with transistor circuits (because of the wide spread of transistor parameters) is not likely to be permanently valid. As manufacturing techniques improve better control of parameters will be effected. In any case some attempt should be made at analysing the circuits we use; and it is hoped that these articles have gone some way in encouraging readers to adopt matrix methods where appropriate.

THIS MONTH'S CONFERENCES & EXHIBITIONS

LONDON

Apr. 11-14 — Chelsea Coll. of Science
Educational Requirements for the Professional Inspection & Quality Engineer
(Instn. of Engineering Inspection, 616 Grand Buildings, Trafalgar Sq., W.C.2.)

Apr. 21-30 — Olympia & Earls Court
International Engineering Exhibition
(F. W. Bridges & Sons, 1-19 New Oxford St., W.C.1.)

Apr. 22-25 — Hotel Russell
International Audio Festival & Fair
(C. Rex-Hassan, 42 Manchester St., W.1.)

Apr. 30 & May 1 — Royal Hotel
Technical Publications & Aids to Technical Publications
(Technical Publications Assoc., 17 Bluebridge Ave., Brookmans Park, Herts.)

BIRMINGHAM

Apr. 5-7 — The University
Conference on Elementary Particles
(Inst. Phys. & Phys. Soc., 47 Belgrave Sq., S.W.1)

BRISTOL

Apr. 7-9 — The University
Stress Analysis Conference
(Inst. Phys. & Phys. Soc., 47 Belgrave Sq., S.W.1)

MANCHESTER

Apr. 5-8 — Col. of Science & Tech.
Physics Exhibition
(Inst. Phys. & Phys. Soc., 47 Belgrave Sq., S.W.1.)

NOTTINGHAM

Apr. 6-9 — The University
Automatic Control Convention
(Inst. Mechanical Engineers, 1 Birdcage Walk, S.W.1)

OVERSEAS

Apr. 5-10 — Paris
Symposium on Memory Techniques
(Société Francaise d'Electroniciens et des Radioélectriciens, 10 avenue Pierre-Larousse, Malakoff (Seine))

Apr. 8-13 — Paris
Electronic Components Exhibition
(F.N.I.E., 16 rue de Presles, Paris 15e)

Apr. 8-13 — Paris
Audio Equipment Exhibition
(F.N.I.E., 16 rue de Presles, Paris 15e)

Apr. 12-17 — Los Angeles
Technical Conference
(S.M.P.T.E., 9 East 41st St., New York 17, N.Y.)

Apr. 13-15 — Houston
Telemetering Conference
(R. W. Towle, Advanced Technology Labs., 369 Whisman Rd., Mountain View, Cal.)

Apr. 14-15 — Cincinnati
Electronics and Instrumentation Conference
(J. R. Ebbeler, Avco Corp., 2630 Glendale-Milford Rd., Cincinnati)

Apr. 20-22 — New York
Symposium on System Theory
(Polytechnic Institute of Brooklyn, 333 Jay St., Brooklyn 1, N.Y.)

Apr. 20-22 — Atlantic City
Frequency Control Symposium
(M. F. Timm, U.S. Army Electronics Labs., Fort Monmouth)

Apr. 21-23 — Pittsburgh
Optimization Techniques
(I.E.E.E., Box A, Lenox Hill Station, New York 21, N.Y.)

Apr. 21-23 — Washington
Nonlinear Magnetics
(Dr. E. W. Pugh, IBM Building, 703-2, Poughkeepsie, N.Y.)

Apr. 24-May 2 — Hanover
Hanover Fair
(Schenkers Ltd., 13 Finsbury Sq., London, E.C.2)

"Simple Transistor Power Supply":—In Fig. 4, page 139 of the March issue, the resistances assume a meter resistance of 1450Ω (0.5 mA, f.s.d.). In the second paragraph, left-hand column, page 140 the reference is to Fig. (a) (not (b)) and in the performance table the ripple should be in *milli*volts.

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MANUFACTURERS' PRODUCTS

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Plug-in Component Module

A NEW component board unit consisting of a twenty-two way plug-in base (identical to that used for the Keyswitch P33 relay) and a circuit component board enclosed in a transparent dust-proof cover has been introduced by Keyswitch Relays Ltd., of 120-132 Cricklewood Lane, London, N.W.2. The component mounting area is 3·125 × 2·218 × 1·093 in and as a demonstration of what can be achieved, Keyswitch have successfully built into a standard unit a ring counter stage complete with power pack. This included 11 trigger tubes, 11 diodes, 65 resistors and 35 capacitors.

Longitudinal copper strips 0·0015 in thick and spaced at 0·2 in intervals are bonded to the board which is pierced with a regular matrix of holes. The maximum working voltage between adjacent copper strips is 500 volts d.c. The price of the Type 304 plug-in component board unit is 30s.

4WW 301 for further details

Cold-cathode Indicator Diode

AMBIENT illumination does not interfere with the operation of the new ZA1004 cold-cathode indicator tube from Mullard Ltd. This tube is primarily intended as a display device for medium/low voltage transistor circuits and a prominent feature is that the control voltage is less than 10 volts and in certain circuits may be kept as low as 3.5 V. The tube has a breakdown voltage of 93.5 V maximum, an extinction voltage of 83.5 V minimum, and a preferred cathode current of 1 mA. Minimum illumination at a distance of 2 mm from the bulb surface is 45 lux. The makers claim a life expectancy of 2,500 hours when the tube is operated at a constant cathode current of 1 mA and a bulb temperature of 35° C.

4WW 302 for further details

Temperature Gauge

A COMPACT portable temperature gauge suitable for measuring temperatures to an accuracy of 1% from −20°C to +120°C has been introduced by Startronic Ltd., of 117a-119a Malden Road, New Malden, Surrey. The instrument has two scales covering −20 to +55 and +50 to +120°C and can be located some distance away from the probe without seriously affecting the accuracy. In fact, a lead resistance of 2Ω only introduces ¼°C error at 100°C.

A selection of matched thermistors are available for the measurement of surface temperatures and a selection of probes can be supplied for the measurement of gas or liquid temperatures. Other accessories include a ten-way selector box and a selection of leads. The instrument weighs 4 lb and measures (case size) 2¾ × 5¼ × 7⅜ in. The price is £31.

4WW 303 for further details

Capacitance Bridge

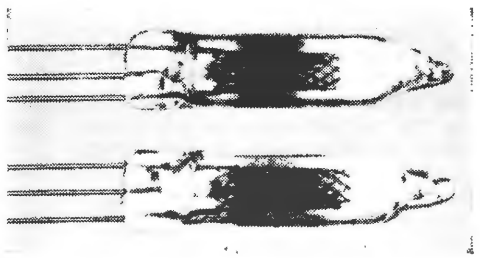
A THREE-TERMINAL 100 kc/s capacitance bridge able to measure 0.0002 to 110.000 pF with a basic accuracy of 0.1% has been developed by the Boonton Electronics Corporation, of New Jersey. This instrument, known as the Model 74D, may also be used for the measurement of conductance, from 0.0001 to 1,000 micromhos, and shut resistance, from 1,000Ω to 1,000 MΩ.

Features of the Model 74D include a continuously variable test signal from 1 mV to 4 V, an internal bias adjustable from −7 V to +144 V, provision for external bias up to ±400 V, negligible warm-up drift, and less than 0.001 pF capacitance drift in 24 hours.

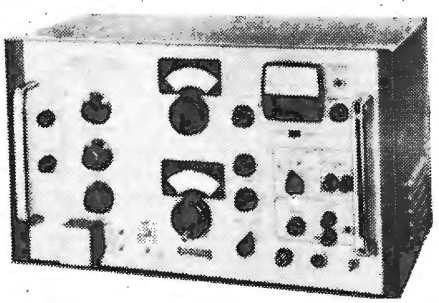
The Model 74D may also be used as a comparison bridge or for "go"-"no-go" testing, as a d.c. output proportional to the bridge unbalance is provided.

This instrument is obtainable in the United Kingdom through Livingston Laboratories Ltd., of 31 Camden Road,

Plug-in component board unit from Keyswitch Relays Ltd.



Two Type ZA1004 cold-cathode indicator diodes from Mullard.



Wide-range three terminal capacitance bridge manufactured by the Boonton Electronics Corp.

Battery-operated Model 142 temperature gauge from Startronic Ltd. It covers the range −20° to +120°C.

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London, N.W.1. The price, excluding duty, is £568.

4WW 304 for further details

Professional Tape Recorder

A PORTABLE tape recorder that weighs less than 11 lb inclusive of batteries is announced by EMI Electronics Ltd., of Hayes, Middx. Features of the new machine include provision for a fourth magnetic head for film and television synchronization, two tape speeds —$3\frac{3}{4}$ and $7\frac{1}{2}$ in/sec—with a run-up time of less than one second, a remote stop-start control which can be embodied in one of the microphones and microphone mixing facilities.

This machine, which should be of interest to those in the broadcast, audio and industrial fields, is designated Type L4. Two microphone amplifiers are incorporated, each with separate volume controls, and require less than 50 microvolts for peak recording level. An EMI motor is used in the machine and speed stability (measured on either speed at a constant 14 volts) is better than 0.2 % of the mean speed from start to finish of a $4\frac{1}{4}$ in spool (maximum size). Wow and flutter is quoted to be better than 0.2 % at both speeds when played back on the same machine. At the higher speed the overall response is within 2 dB from 50 c/s to 12,000 c/s and at $3\frac{3}{4}$ in/sec within 2 dB from 50 c/s to 5,000 c/s.

Separate record and replay amplifiers are housed within the main chassis with a monitor amplifier (provided with a 3 in speaker for checking the information on the tape on replay only) and oscillator unit which operates, with variable bias, at approximately 60 kc/s. The 14 volt battery for this machine is rechargeable.

4WW 305 for further details

Wall Speaker Unit

AN inexpensive sound reinforcement loudspeaker unit, Type BG, that can be fitted into a wall is announced by K.L.B. Electric Ltd., of 335 Whitehorse Road, Croydon, Surrey. A seven by four-inch speaker with a three-watt power-handling capacity is fitted as standard although speaker size can be varied to customer requirements.

The unit requires a wall area of 9×6 in and can easily be accommodated after the removal of two bricks. Alternative fixings are provided for mounting in a standard builder's "knock-out box." The price of the unit complete with 100 volt line transformer is £2 17s 6d.

4WW 306 for further details

Digital Circuit Modules

INTENDED for applications up to 10 kc/s are the new Series 10A (open) and 10B (potted) digital modules from the electronic services division of Standard Telephones and Cables Ltd. The Series so far includes two- to five-input gates; low-, medium- and high-power inverters; low-, medium- and high-power buffers; and several multi-stable and peripheral equipment circuits. Module design is characterized by very sharp pulse edges ensuring positive response and immunity from noise. These units are designed to have a life span of at least twenty years and will operate within the temperature range −10° to +70° C. The division's address is Edinburgh Way, Harlow, Essex.

4WW 307 for further details

Nanovolt Source

PRIMARILY designed to function as a secondary standard for calibrating low-voltage ranges on instruments, the Model 260 nanovolt source manufactured by Keithley Instruments Inc., of Cleveland, Ohio, is simple to operate and may be set with a three-digit resolution for any value from one nanovolt to one volt. Separate take-off points are provided for nanovolts, microvolts and millivolts. A source resistance of 1 Ω is quoted for the two lower ranges and 100 Ω for millivolt outputs. Long-term accuracy is specified to be within 0.25 % to 0.75 %, according to the range in use.

The Model 260, which can also be used to provide an accurate voltage source for zero suppression, potentiometric measurements and the like, is available in the United Kingdom through Livingston Laboratories Ltd., of 31 Camden Road, London, N.W.1.

4WW 308 for further details

D.C. Multimeter

THIRTEEN voltage, thirteen current and sixteen resistance ranges are provided on the Millivac Type MV-77B d.c. multimeter. This instrument features a floating input, an output suitable for connection to a recorder, and a six-inch mirror-scale meter with taut-band suspension.

As a voltmeter it covers 1 mV to 1,000 V full scale in 13 ranges, each of which has individual calibration controls. The accuracy is quoted to be within 3% on the 1 mV range, 2% on the 2·5 mV to 10 mV ranges and within 1% on all ranges from 25 mV up to 1,000 V. Input impedance is 10 MΩ on the ranges up to 100 mV, 25 MΩ on the 250 mV range and 100 MΩ on all higher ranges.

The accuracy of the instrument in the current mode is within 2% on all ranges, except on the lowest, where it is 3%. Shunt resistances range from 1 kΩ on the lowest range to 0·01Ω on the highest, thus keeping the voltage drop to below 10 mV full scale over the entire range from 1 μA to 1 A.

The first 13 resistance ranges, from 1 Ω to 1 MΩ full scale, utilize the voltage scales which are linear and provide an accuracy of ± 2%. The terminal voltage on these ranges never exceeds 10 mV, thus making the instrument suitable for testing microminiature electronics, such as thin films. The three other resistance ranges, which have their own logarithmic scales, extend the measurement range up to 100 MΩ with a 5% accuracy and up to 5,000 MΩ at ±10%.

Overall dimensions of the instrument are $13 \times 8\frac{1}{2} \times 11$ in and it weighs 25 lb. A rack-mounted version, designated Type RM-77B, is also available in the United Kingdom through the instruments division of Claude Lyons Ltd., of 76 Old Hall Street, Liverpool, 3 (Southern offices Hoddesdon, Herts.). The price, excluding Government charges, is £148 2s 6d.

4WW 309 for further details

Spark Eroder

BROKEN taps and drills of minute dimensions—down to 12 B.A.—can be

INFORMATION SERVICE FOR PROFESSIONAL READERS

To expedite requests for further information on products appearing in the editorial and advertisement pages of *Wireless World* each month, a sheet of reader service cards is included in this issue. The cards will be found between advertisement pages 48 and 51.

We invite readers to make use of these cards for all inquiries dealing with specific products. Many editorial items and all advertisements are coded with a number, prefixed by 4WW, and it is then necessary only to enter the number(s) on the card.

Readers will appreciate the advantage of being able to fold out the sheet of cards enabling them to make entries while studying the editorial and advertisement pages.

Postage is free in the U.K. but cards must be stamped if posted overseas. This service will enable professional readers to obtain the additional information they require quickly and easily.

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removed with the "Arc-out" spark eroder developed by Watton Electronic Ltd., of Welwyn Garden City. The cores of taps and drills from any metal down to 12 B.A. size can be removed, claim the manufacturers, without damage to the thread or hole. The "Arc-out" can also be used for machining hardened metals, and any shape of hole is possible.

Apart from a normal a.c. mains supply (consumption 2 A to 240 V a.c.), it requires only a small flow of water. Two models of the "Arc-out" are available, the Model 1A which has a height clearance of 10 in and the 1B which has a 16 in clearance. Both models are supplied complete with electrode clamp nut, two electrode adaptors, a tubular electrode, five different sized insulated wire electrodes, and a water hose. The Model 1A is priced at £65 15s 0d and the 1B at £69 17s 6d.

These units are available through Roberts Electronics Ltd., of 17 Hermitage Road, Hitchin, Herts.

4WW 310 for further details

Sub-miniature Electrolytics

SOLID electrolytic tantalum capacitors comparable in size to lighter flints—a typical example is 4 mm long by 1·8 mm diameter—are being produced by the dielectric and magnetic division of Plessey-UK Ltd., at Towcester, Northants. Designated Type M, the capacitance range of the new series is from 0.047μF to 10μF at d.c. working voltages from 1·5 to 50 V. Other characteristics include a temperature range of −55°C to +85°C, a power factor of 25% of maximum at 120 c/s, leakage current not greater than two microamps at 20°C and a surge voltage rating of 16% above the rated working voltage.

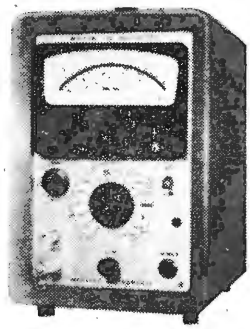
These polarized units are designed to operate with a d.c. bias and to avoid reverse polarity, the peak value of any a.c. component must not exceed the applied d.c. bias. Also, the sum of the d.c. bias voltage and the peak value of any a.c. component must not exceed the rated working voltage of the capacitor.

Tinned nickel contact leads of 0·010 in diameter are welded to the anode and soldered to the cathode. Each unit is metallic coated and encapsulated in epoxy resin.

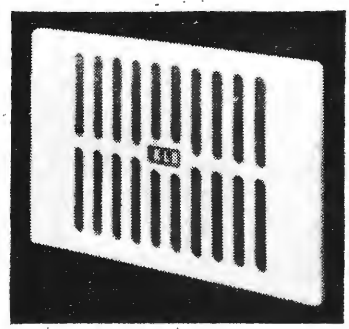
4WW 311 for further details

Logic Circuit Elements

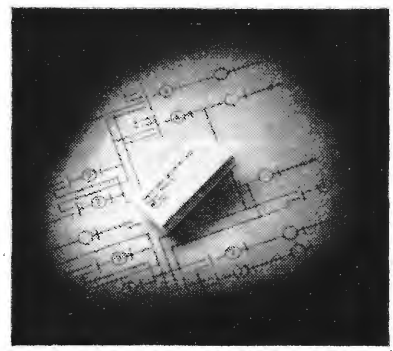
THREE new series of logical switching elements presented in rectangular encapsulations are announced by Ferranti Ltd. The 400 Series, an alternative to the current 300 Series, employ sili-



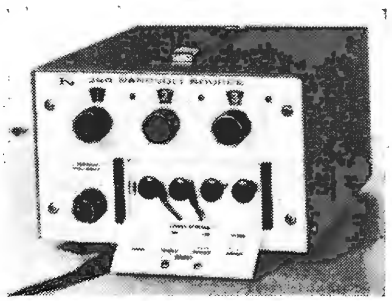
Millivac d.c. multimeter obtainable through Claude Lyons Ltd.



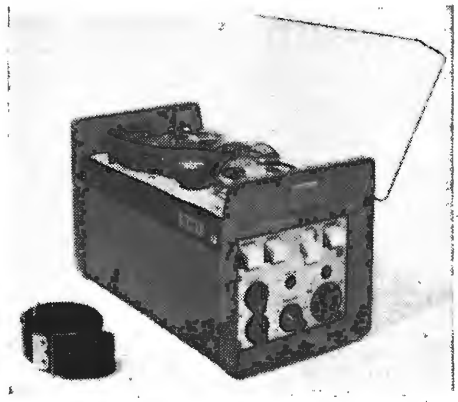
Wall loudspeaker unit from K.L.B. Electric Ltd. It can be fitted in place of two bricks.



Type 10B potted circuit module for control and data systems from S.T.C. This unit measures $2\frac{1}{2} \times 1 \times 1$ in, excluding connections.



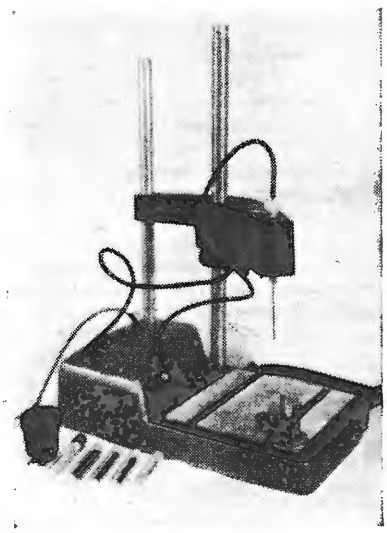
Model 260 nanovolt source made by Keithley Instruments Inc.



EMI Electronics Type L4 portable tape recorder. Full and half track versions are available.

Plessey Type M "Castanet" tantalum capacitor shown against a cigarette lighter.

Watton "Arc-out" spark eroder for removing small broken taps and drills. It is suitable for use down to 12 B.A.



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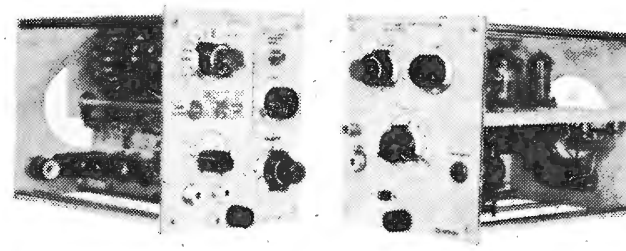
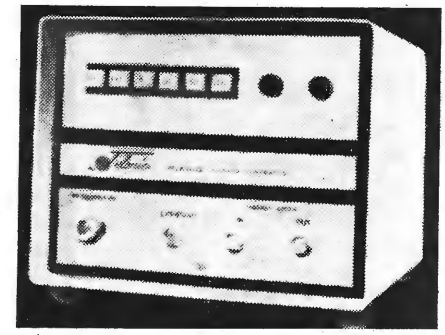
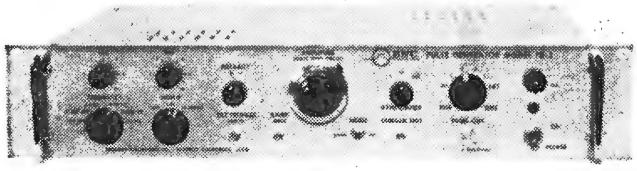
Ferranti 700 Series of logic circuit elements. They weigh less than 10 gm.



Two new plug-in units for Solartron oscilloscopes. A high-gain differential amplifier is shown on the left and a wide-band amplifier on the right

Telonic microwave marker generator. It features push-button controls.





Sliding pulse generator from Berkeley Nucleonics.

con active elements and have switching speeds in excess of 3 Mc/s; temperature range is from −40° to +100°C. Switching speeds in excess of 5 Mc/s are quoted for the 500 Series, which contain silicon transistors and gold-bonded germanium diodes.

The other new modules, the 700 Series, have been developed primarily for industrial applications and have switching speeds in excess of 1 Mc/s. Operating temperature range for this series and the 500 Series is from −20° to +90°C.

All circuits operate on standard supply rails of +12 V and −6 V, with a nominal tolerance on all rails of ±0.5 V. Logic levels for the new modules are similar to those specified for the current Ferranti range, and all electrical outlets are in the form of flying leads; the maximum number is 14. These modules measure 1.48×0.45×0.55in, and in many cases can be provided mounted on printed circuit boards to fulfil standard functions such as decade counters, shift registers, adders, decoders, etc.

4WW 312 for further details

Sliding Pulse Generator

CAPABLE of producing a train of linearly increasing pulses suitable for testing differential linearity in amplifiers, pulse height analysers and analogue-to-digital converters is the Model PB-2 generator from Berkeley Nucleonics Co., of California. Transistors are used throughout the PB-2 which can also be used as a conventional precision pulse generator.

Pulse height linearity and stability are stated to be better than 0·1%. Repetition rate is adjustable from 1 c/s to 1 Mc/s and the output amplitude is calibrated from 1 mV up to 10.1 V. Coarse adjustment is by a step attenuator and fine adjustment by a 10-turn potentiometer. The rise time is adjustable from 0.05 to 2 μsec and pulse width from 0.3 to 100 μsec.

The Model PB-2 is available in the United Kingdom through High Volt Linear Ltd., of 1 Cardiff Road, Luton, Beds.

4WW 313 for further details

Microwave Marker Generator

DESIGNED to provide marker intervals on swept frequency displays is the Model TMS-1 microwave marker generator from Telonic Engineering Incorporated. This instrument will operate on any frequency within the range 5 Mc/s to 10 Gc/s and provide 5, 10, 50 or 100 Mc/s markers accurate to ±0.001%. Other markers between 2 and 200 Mc/s may be generated by feeding the instrument with a signal of the appropriate frequency. The TMS-1 is marketed in the United Kingdom by Livingston Laboratories Ltd., of 31 Camden Road, London, N.W.1. The price, excluding Government charges, is £646.

4WW 314 for further details

Plug-in Scope Units

TWO new plug-in units for the Solartron Type CD1212 (CT484) and CD1220 oscilloscopes are announced. One of these, a high-gain differential amplifier designated CX1258 features a high d.c. sensitivity (100 μV/cm), high in-phase rejection (80 dB) and very low drift. The maximum bandwidth of this amplifier is 200 kc/s making it suitable for a wide range of general purpose applications. The sensitivity of the amplifier is adjustable from 100 μV/cm to 2 V/cm in 14 calibrated ranges and maximum sensitivity is quoted to be 100 μV from d.c. to 50 kc/s, 200 μV from d.c. to 100 kc/s and 500 μV from d.c. to 200 kc/s. Maximum in-phase voltage is ±25 V peak from 100 μV/cm to 20 mV/cm and ±250 V peak from 20 mV/cm to 2 V/cm. Calibration accuracy is 3%.

The other unit, the CX1259, is a wide-band amplifier and has a similar performance to the CX1256, but includes an additional x10 d.c. coupled transistor amplifier providing a maximum sensi-

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tivity of 5 mV/cm at a bandwidth of d.c. to 24 Mc/s. With the additional amplifier out of circuit, the sensitivity of the CX1259 is 50 mV/cm from d.c. to 40 Mc/s. Both of these units are available from the Solartron Electronic Group Ltd., whose address is Farnborough, Hampshire.

4WW 315 for further details

Slip Clutches & Couplings

A RANGE of precision slip clutches and couplings for use in servomechanisms and small mechanical devices are now available from Bowmar Instrument Ltd., of Sutherland Road, London, E.17. Two sizes of slip clutches are being offered which can be pre-set to slip at torques between 2 oz/in and 20 oz/in. Various combinations of shaft sizes can be accommodated from 0.120 to 0.250 in and these are clamped by means of two set screws in the hub. These should be found particularly useful for the protection of multi-turn precision potentiometers in servo systems.

The precision couplings are also in two sizes, one for transmitting up to 8 oz/in torque without backlash, the other for 16 oz/in. Shaft sizes are also from 0.120 to 0.250 in and are held in position by either a set screw in the hub or a split collet type of hub.

4WW 316 for further details

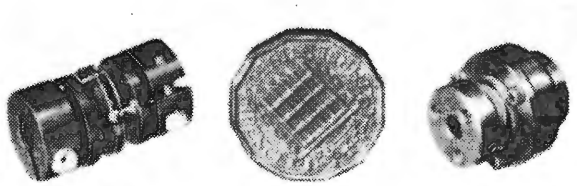
Frequency Selective Amplifier

A PORTABLE frequency selective amplifier covering 10 c/s to 100 kc/s has recently been introduced by H. Tinsley & Co., of Werndee Hall, South Norwood, London, S.E.25. Four ranges are used to cover the spectrum, and frequency is selected by decade switches. A "Q" factor of better than 30 is quoted.

Three stages of amplification are incorporated in the Model 5710 providing voltage gains of the order of 10^6. The input impedance of the instrument, which can handle signals from 1 μV to 10 V, varies according to the amount of internal attenuation. This may be adjusted from 10 to 120 dB and will cause the input impedance to vary from 10 kΩ for a 10 μV signal to 1 MΩ for larger signals requiring more than 50 dB attenuation.

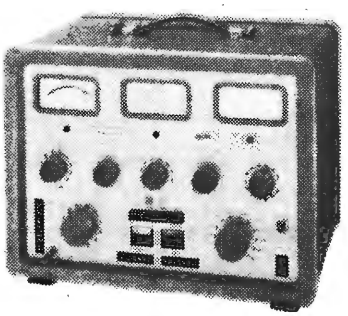
The dimensions of the Model 5710 are 12 × 4 × 8½ in and it weighs 5lb. An alternative model, designated 5711, calibrated in angular frequency is also available. Both instruments use transistors throughout.

4WW 317 for further details

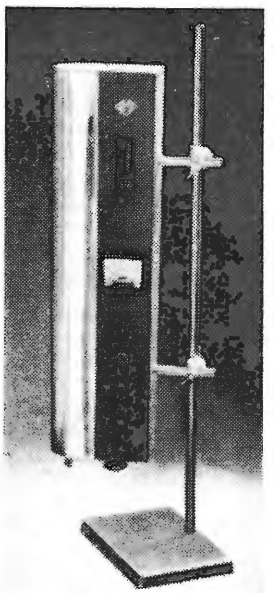


A precision coupling (shown on the left) and slip clutch from Bowmar Instrument Ltd.

Frequency selective amplifier covering 10c/s to 100kc/s made by H. Tinsley & Co.



Philips transistor analyser Model PM6505A. It can measure leakage currents down to 10 nA f.s.d.



Machine for producing ultra-pure hydrogen (Johnson. Matthey & Co.) It weighs less than 15 lb.

Ultra-pure Hydrogen Machine

A SIMPLE-TO-OPERATE machine for producing ultra-pure hydrogen by the silver-palladium diffusion method is announced by Johnson, Matthey & Co. Ltd., of 73-83 Hatton Garden, London, E.C.1. This unit, known as the A.1 diffusion unit, should be of particular interest to those in research and development laboratories as it will give an ultra-pure output of up to 1.5 cu ft/hr. Connection to a hydrogen source is made by a steel coupling pipe and the output points are rust-protected to allow plastic tubing to be used.

The unit will operate from any 220-250 volt a.c. supply, via a power regulator—such as the Variac Duratrack—and requires only 600 watts when operating at the maximum temperature (400° C). The average working temperature of the instrument is 350° C, providing an output level of 1 cu ft/hr. This diffusion unit is housed in an aluminium case and is mounted on a laboratory retort stand.

4WW 318 for further details

Transistor Analyser

THE latest transistor analyser from Philips, the Model PM6505A, which is an improved version of the PM6505, has a 10 nanoamps f.s.d. range for leakage currents.

A continuously adjustable collector voltage source, a base current supply, a tuned 1 kc/s oscillator for dynamic measurements, and an adjustable half-wave voltage source for the display of breakdown voltage characteristics are provided. All of these supply circuits are protected against accidental short-circuiting, and all with the exception of the half-wave source are fully stabilized. The measurements that may be made are: collector-emitter short-circuit test; collector-emitter, emitter-base and collector-base leakage currents; collector current as a function of base current and also as a function of base-emitter volt-

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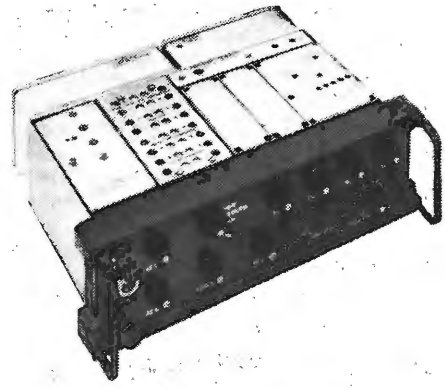
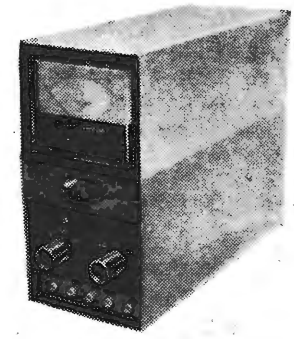
age; knee voltage; short-circuit impedance h_{ie}; and short-circuit current gain h_{fe}. The collector voltage is adjustable from 0 to 60 volts with a maximum collector current of 3 amps. The h parameters are measured at 1 kc/s, h_{ie} covering the range 0 to 30 kΩ and h_{fe} 0 to 1,000.

The analyser, which is a mains-operated unit and weighs 42 lb, can also be used for selecting and matching transistors. Its dimensions are 13 × 16 × 11½ in, and it is obtainable in the U.K. through the M.E.L. Equipment Company, 207 Kings Cross Road, London, W.C.1.

4WW 319 for further details



Redifon Type GR 345 10,000-channel 2-12 Mc/s portable transmitter-receiver.



In-circuit transistor leakage tester made by Transition Inc.

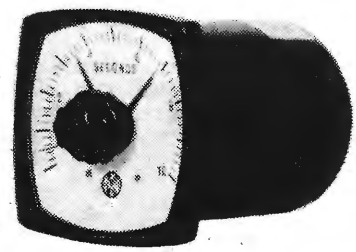
Portable 2-12Mc/s Transceiver

A NEW "Manpack" transmitter-receiver that covers the frequency range 2-12 Mc/s in 1 kc/s steps is being manufactured by the communications division of Redifon Ltd., of Broomhill Road, London, S.W.18. Although this s.s.b. is being manufactured under licence from the Hughes Aircraft Company, of California, it has full a.m. capability—making it suitable for use with existing military and civil equipment—and better sensitivity figures than the original Hughes version.

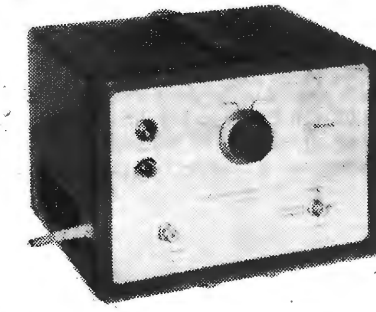
A frequency synthesizer is used to obtain the 10,000 channels in the frequency range 2-12 Mc/s. This, of course, does away with the need for "netting" and enables the equipment to be operated by relatively unskilled personnel. A typical frequency tolerance for the equipment, designated GR 345, is quoted to be ±25 c/s, and never greater than ±50 c/s under any combination of extreme conditions.

The power output of the transmitter is 15 W p.e.p. on c.w. and s.s.b., and 3.75 W carrier (minimum) on a.m. with 100 % modulation. Receiver sensitivity is quoted to be 1.4 μV (3.0 μV on a.m.) for a 10 dB signal plus noise to noise ratio. The basic transmitter-receiver including the power pack—which is one of the six modules—weighs 22 lb. Many accessories are available for the GR 345.

4WW 320 for further details



Industrial solid state process timer being made by Kent Precision Electronics Ltd. Range is from 10 msec to 15 sec.



Add-on unit from Advance Electronics Ltd to extend the frequency range (to 100 Mc/s) of electronic counters.

Solid State Process Timers

A NEW range of solid state process timers for industrial applications is announced by Kent Precision Electronics Ltd., of Vale Road, Tonbridge, Kent. These instruments, which are suitable for timing over the range 10 msec to 15 sec with an overall accuracy of ±1 %, can also be supplied with pulsed outputs; to fire thyristor circuits for the control of power circuits. They are housed in panel-mounting instrument cases and consist basically of a stable resistive-capacitive timing circuit and a transistor voltage threshold detector which fires the thyristor output circuit. For relay operation a low-power thyristor is used to operate an internal relay.

A feature of these instruments is that two units can be housed in the same case enabling the instruments to be interconnected. This allows one instrument to be initiated after the first has elapsed, etc. Alternatively, a dual instrument may be used as two separate timers with concentric controls.

4WW 321 for further details

In-circuit Transistor Tester

AN instrument designed for in-circuit measurement of transistor leakage current, which was developed by the IIT Research Institute, of Chicago, is now being manufactured and marketed by Transition Incorporated, of 10 W 35th Street, Chicago, Illinois. Collector-to-base leakage currents from 1 μA to 2.5 mA with a collector resistance down to 100 Ω can be measured with this instrument, which is claimed to be simple to operate and not to damage other circuit components.

The accuracy for transistor leakage between collector and base with emitter and collector junctions reverse biased is quoted to be within 1 % for collector resistances greater than 500 Ω with full scale meter readings. For collector resistances between 100 Ω and 500 Ω accuracy is within 5%.

4WW 322 for further details

Counter Add-on Unit

ABLE to extend the range of most electronic counters now commercially available to 100 Mc/s is the new add-on unit Advance Electronics Ltd. have introduced. Designated TCD100, the new instrument provides division factors of 100 or 20 and has an input sensitivity of 50 mV (into 50 Ω). Both the input and output parameters are flexible to accommodate a wide range of input sources and the instrument will provide output pulses at 3 V peak-to-peak (50 Ω) from 10 kc/s to 1 Mc/s on the divide by 100 setting and from 50 kc/s to 5 Mc/s on the ÷ 20 setting. The manufacturers claim that the accuracy of the basic counter is not affected by the divider unit.

Transistors and tunnel diodes are used in the instrument which measures 6½ × 9½ × 8¼ in and weighs 8¼ lb. The price of the TCD100 is £195 and it is available from the company's headquarters in Roebuck Road, Hainault, Ilford, Essex.

4WW 323 for further details

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The Computer Industry

A FLOURISHING British computer industry and a rapid increase in the use of computers and computer techniques in industry and commerce are considered essential by the Government, and plans to serve these ends were announced by the Minister of Technology, Mr. Frank Cousins, on March 1st.

A Computer Advisory Unit within the Ministry of Technology to advise on computer requirements over the whole public sector is to be formed. All proposals for computers required by Government Departments for civil purpose and those to be purchased with public monies by universities, colleges and research councils will be referred to this unit for objective technical appraisal before purchases are authorized.

The Government has also initiated a full-scale review of the computer requirements of universities, colleges and research councils so that a new five-year programme of procurement can be planned. The Government proposes to start this five-year programme at a rate of £2M a year.

Further programmes of research into computer techniques and the development of new equipment within industry, the universities and in Government research establishments and in the Post Office will be initiated. In addition, the National Research Development Corporation will be greatly expanding its work in this field, and in this connection is to invest £5M in a series of joint projects with International Computers and Tabulators Ltd.

The Minister is also exploring with the industry and with users the possibilities of establishing a National Computer Programme Centre in which they would be partners with the Government.

Reciprocal Amateur Operation

THE Postmaster-General announced on March 16th that in future he will, subject to certain conditions being met, grant licences to engage in amateur transmissions in Great Britain to nationals of countries which are prepared to grant similar facilities to United Kingdom licensed radio amateurs.

The U.S. Federal Communications Commission has, with effect from March 27th, also adopted rules to carry into effect the "reciprocal operating" provisions included in the U.S. Communications Act. A permit will be issued to those who hold a valid amateur transmitting licence in their own country, if there is a bilateral agreement between the U.S. and that government for reciprocal operation as now provided for in the U.K.

America is therefore the first country with which we have this reciprocal arrangement. It will be necessary to negotiate with other countries to make similar arrangements although, of course, not with countries within the Commonwealth.

Dutch Nationalized Relay System

THE success of the Dutch P.T.T's experiments with a central aerial system to provide a four-programme piped-television service together with ten v.h.f. sound programmes to 2,200 homes in a district in the Hague has prompted the government to make plans to introduce the system on a national scale. The P.T.T. will be responsible and the investment cost is estimated at the equivalent of about £16M. The subscription is expected to be about 8s per month.

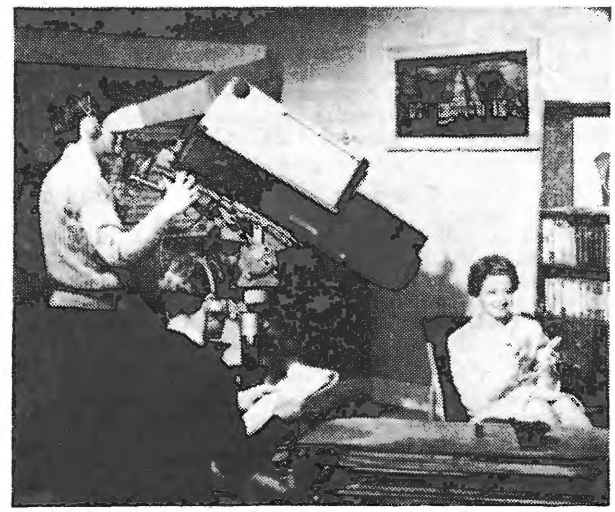
In the Hague experiment subscribers have had the choice of television programmes from Belgium, France and Germany as well as the Dutch service. Normal receivers can be linked to the system.

Subscription TV in the U.S.

AFTER nearly three years' experimental operation of its "over-the-air" subscription television system in Hartford, Conn., the Zenith Radio Corporation has asked the Federal Communications Commission to authorize subscription TV on "an extended nation-wide basis." Analysis of the first two years' operation of the pilot scheme, using the Phonevision system and serving 4,775 homes, shows that a little over 5% of viewing time was devoted to subscription television. Charges for programmes ranged from 25 cents to $3.

In the Phonevision system the vision signal is scrambled by inverting the picture polarity, shifting picture information relation to sync by some 3% of the width of the picture on alternate strips of seven lines and by varying the vertical position of these displaced strips in each field. Sound is also scrambled. Each programme is coded and in the subscriber's "box" is a punched tape with sets of holes for some 2,000 different programme numbers. When the appropriate number has been selected and the switch set to "buy" a programme the tape is marked for subsequent payment of the fee.

An international conference on **u.h.f. television** covering receiver and transmitter design, propagation, receiving and transmitting aerials, parametric amplifiers, and test equipment, is to be held in London on September 1st and 2nd—during the Radio Show. The sponsoring bodies are the I.E.E., I.E.E.E., I.E.R.E. and the Television Society. The venue is not yet decided. It is hoped that technical visits will take place on the day immediately after the conference. Details of these, and of the registration fee, will be available later from the Joint Conference Secretariat, 8-9, Bedford Square, London, W.C.1.



***Ease and flexibility of operation** characterize Marconi's small and light transistorized 4½-inch image orthicon television camera, Mark V. A single zoom lens, with means for preselecting under servo control any of four fixed zoom positions, eliminates the restrictions imposed by a number of separate lenses of fixed focal length. Controls for the camera electronics have been transferred to the associated equipment racks, and a tilting viewfinder enables the operator to view comfortably at any camera angle.*

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For the next two years the **Physics Exhibition** will be held in London but at a new venue—Alexandra Palace. The dates are March 28th-31st, 1966, and April 17th-20th, 1967. The organizers, the Institute of Physics & Physical Society, say that the following two exhibitions may be held in the Provinces.

Three exhibitions to be held simultaneously at Earls Court, London, from June 15th to 19th will all have items of interest to some readers of *Wireless World*. They are: the first Noise and Vibration Reduction Exhibition (NAVREX), the second Church and School Equipment Exhibition (CASEX) and the first Pumping Exhibition. The organizers are Iliffe Exhibitions Ltd., Dorset House, Stamford Street, London, S.E.1, from whom tickets are obtainable free for NAVREX and the pumping show. Admission to CASEX will cost 2s 6d.

Next year's conference on **solid state physics,** organized by the Institute of Physics & Physical Society, will be held in Manchester instead of Bristol as in the past. The date will be January 4th-7th and the place, the Renold Building, Manchester College of Science and Technology.

"**Microwave applications of semiconductors**" is the title of the joint I.E.R.E.-I.E.E. symposium being arranged for June 30th to July 2nd at University College, London. The six main sessions will cover microwave properties of semiconductor devices, generators, p-i-n diode circuits, tunnel diode circuits and mixers, low-noise devices and systems. Further information and registration forms are obtainable from the I.E.R.E., 8-9 Bedford Square, London, W.C.1.

A British Joint Computer Conference is to be held at the Congress Theatre, Eastbourne, Sussex, from May 3rd to 5th, 1966, under the aegis of the United Kingdom Automation Council. Participating organizations include the I.E.E., I.E.R.E. and the British Computer Society. Further details and registration forms will be available in due course from the conference secretariat, I.E.E., Savoy Place, London, W.C.2.

"The challenge of improving the exports of the electronics industry" is to be the theme of the second **Exports Day** to be held by the Radio & Electronic Component Manufacturers' Federation. The conference, which is to be on May 11th at the Federation's headquarters at 11 Hanover Street, London, W.1, will be attended by representatives from the 200 or more member firms of R.E.C.M.F.

V.H.F./U.H.F. Convention.—The eleventh international v.h.f./u.h.f. convention organized by the Radio Society of Great Britain, will be held at Kingsley Hotel, Bloomsbury Way, London, W.C1, on April 10th. It opens at 11.0 with a trade exhibition and in the afternoon there will be a lecture programme. Tickets, costing 4s 6d (convention only) or 30s (convention and dinner), are obtainable from F. E. A. Green (G3GMY), 48 Borough Way, Potters Bar, Middx.

Microelectronics.—A symposium on the applications of microelectronics is to be held at Southampton University from September 21st to 23rd. It is under the joint sponsorship of the Southern Sections of the I.E.E. and I.E.R.E. in association with the Department of Electronics at the University, from which registration forms are obtainable.

The eighth **International Instrument Show** to be staged by B & K Laboratories will this year be held at Grosvenor House, Park Lane, London, W.1, from May 17th to 21st. The second Environmental Engineering Symposium will also be held during the same period. Tickets for both are obtainable by bona-fide engineers and designers from B & K Laboratories, 4 Tilney Street, London, W.1.

This year's **Fleming Memorial Lecture** of the Television Society is being given at the Royal Institution, Albemarle Street, London, W.1, at 7.0 on April 29th, by Dr. R. D. A. Maurice, assistant head of the B.B.C.'s Research Department. His subject is "The specification of an adequate television signal." Admission is by ticket obtainable from the Society at 166 Shaftesbury Avenue, London, W.C.2.

E.E.A. Officers.—At the annual general meeting of the Electronics Engineering Association on March 16th R. Telford, of the Marconi Company, was elected chairman in succession to W. D. H. Gregson (Ferranti) who held the office for two years. The new vice-chairman is R. J. Clayton (G.E.C. Electronics).

B.B.C. in West Africa.—In order to extend the coverage of the B.B.C.'s transmissions in West Africa arrangements have been made for a new medium-wave transmitter in Monrovia to relay programmes for 10 hours every day. The Liberian Broadcasting Corporation, for which Rediffusion provides commercial and technical management, will be responsible for the operation and maintenance of the transmitter and for the reception, recording and relaying of programmes. The agreement is the first of its kind that the B.B.C. has made in Africa involving a commercial organization.

Baird Scholar.—The Television Society invites applications for the third award of the John Logie Baird Travelling Scholarship. Valued up to £200 it is open to post-graduate students (in United Kingdom educational establishments) who are concerned with television engineering or an allied technology. The Scholarship is intended to assist the successful applicant in undertaking a period of investigation abroad of approximately 6-8 weeks. Application forms, which must be returned by April 17th, are obtainable from the Society at 166 Shaftesbury Avenue, London, W.C.2.

Oscar III the translator satellite for amateur use, was launched by the U.S. Army on March 9th at 18.30 G.M.T. into an orbit with a period of 103½ minutes. The orbit is circular, with a height of 502 miles and an inclination of 70°. The beacon and translator are reported to be functioning. Information regarding Oscar III may be obtained from W. H. Allen, 24 Arundel Road, Tunbridge Wells, Kent, who wrote on the project in our January issue.

A southern section of the **Society of Electronic and Radio Technicians** has been formed in the Portsmouth-Southampton area bringing the total to nine. The others are in Birmingham, Bristol, Glasgow, Leeds, London, Manchester, Newcastle upon Tyne and Nottingham. The Society's membership had grown to 366 in ten weeks.

Radio and Television Servicing Film.—A 16 mm colour film showing how a radio and television service engineer is trained and what his work involves was made for the British Radio Equipment Manufacturers' Association and shown for the first time at last year's National Radio and Television Show. The 14-minute sound film is now available on free loan from the Central Film Library, Central Office of Information, Hercules Road, London, S.E.1, and also from Sound Services Ltd., Wilton Crescent, Merton Park, S.W.19.

The twelfth **International Spectroscopy Colloquium** is to be held under the auspices of the British Spectroscopists Co-ordinating Committee and the Institute of Physics & Physical Society in the University of Exeter, from July 12th-17th. Information and registration forms may be obtained from Mrs. C. E. Arregger, 1 Lowther Gardens, London, S.W.7.

R.E.C.M.F. Directory.—A list of the member firms of the British Radio and Electronic Component Manufacturers' Federation, together with a list of trade names and buyer's guide, has been produced. It is available free from the R.E.C.M.F., 6 Hanover Street, London, W.1.

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PERSONALITIES

Admiral of the Fleet the **Earl Mountbatten of Burma,** K.G., P.C., has been elected to honorary membership of the Institution of Electrical Engineers "for his distinguished services to the United Kingdom and Commonwealth in war and peace, and for his contributions to the progress of electrical and electronic

Earl Mountbatten

science and engineering." Lord Mountbatten, who is Chief of the Defence Staff, joined the Royal Navy in 1913, and during his early naval career specialized in wireless and wrote two handbooks for the Navy on wireless telegraphy. He has retained his interest in radio and electronics and has been vice-patron of the Institution of Electronic & Radio Engineers (formerly Brit. I.R.E.) since 1948. He became chairman of the newly formed National Electronics Research Council last July.

C. L. G. Fairfield, M.A.(Cantab.), M.I.E.E., Barrister at Law, has been appointed assistant managing director of Submarine Cables Ltd. (owned jointly by A.E.I. and B.I.C.C.). He joined the board of the Company in 1958. Mr. Fairfield was with Mullard from 1948 to 1953 first as assistant to the directors on technical matters and later as manager of the valve division. He was also a director of Mullard Equipment Ltd. He joined the Telegraph Construction & Maintenance Co. —a subsidiary of B.I.C.C.—in 1953 and was appointed to the board in 1958.

Graham Miller, B.Sc., who joined Wayne Kerr in 1959 and for the past three years has been sales manager of the Company's American subsidiary in Philadelphia, has been appointed general sales manager of the parent company. Mr. Miller graduated in physics at Swansea University after studying electronics at the Manchester College of Technology and was for two years head of the Ferranti Standards Laboratory before joining Wayne Kerr.

The forty-third award of the Faraday Medal of the Institution of Electrical Engineers is to be made to **Dr. Vladimir K. Zworykin** "for his notable scientific and industrial achievements, including the invention of the iconoscope, and for his important role in medical electronics." Dr. Zworykin, who is honorary vice-president of the Radio Corporation of America, was born in Murom, Russia, in 1889, went to the United States in 1919, and was naturalized in 1924. He holds the degrees of Ph.D. (University of Pittsburgh) and D.Sc. (Polytechnic Institute of Brooklyn). After research work with Westinghouse Electrical and Manufacturing Company, Dr. Zworykin was, from 1929 to 1942, director of electronics research at the R.C.A. Manufacturing Company. Since 1942 he has devoted himself to the activities of R.C.A. Laboratories.

Group Captain E. Fennessy, C.B.E., B.Sc., M.I.E.E., has resigned as managing director of Decca Radar Ltd., and also his directorships of other companies in the Decca Group. He has joined the Plessey Group which, as reported elsewhere, has acquired the ground radar and data-handling divisions of Decca. Gp. Capt. Fennessy, who is a graduate of London University, was a member of the original radar research team under Sir Robert Watson Watt at Bawdsey and in 1940 was commissioned in the R.A.F.V.R. and worked on the planning, construction and operation of radar systems both in this country and abroad. After the war he joined the board of the Decca Navigator Company and became managing director of Decca Radar when the company was formed in 1950.

Peter H. Parkin, B.Sc., A.M.I.E.E., acoustics scientist at the D.S.I.R. Building Research Station, has received the 1964 Wolfe Award "for his work on acoustic design in buildings and his invention of 'assisted resonance' for modifying and improving hearing conditions in auditoria." The £500 award is made under the terms of the Wolfe bequest for research workers in D.S.I.R. who make an outstanding contribution to the Department's research during the previous year. Mr. Parkin was in the Admiralty during the war working on counter-measures to magnetic, acoustic and pressure mines. He has been at the Building Research Station, near Watford, since 1946 where he latterly devised the system of "assisted resonance," or electronic-controlled reverberation time, which has recently been introduced in the Royal Festival Hall. He was concerned with the original design of the Hall and he devised the speech reinforcement system installed in St. Paul's Cathedral in 1951.

Sir Albert Mumford, K.B.E., B.Sc., M.I.E.E., engineer-in-chief at the Post Office since 1960, retired on March 19th. Sir Albert, who is 62, entered the Post Office in 1924 after graduating at Queen Mary College (London University), of which he is a Fellow. He was for some time in the Radio Laboratories of the Dollis Hill Research Station before joining the Radio Branch staff at Headquarters, where in the early post-war years he led the U.K. delegations to a number of international radio conferences. Sir Albert was president of the Institution of Electrical Engineers last year. The new engineer-in-chief is **D. A. Barron,** C.B.E., M.Sc., M.I.E.E., who graduated at Bristol University and joined the Post Office in 1927 at the age of 20. He has been in the Telephone Branch of the Engineering Department since 1940 and played a major part in the introduction of the Subscriber Trunk Dialling system and in

D. A. Barron

the development of electronic telephone exchanges. He has been deputy engineer-in-chief since 1960 and is succeeded by **J. H. H. Merriman,** O.B.E., M.Sc., A.Inst.P., M.I.E.E., who became an assistant e.-in-c. in 1963. Mr. Merriman graduated at King's College, London, and did post-graduate work on non-linear oscillations to gain his M.Sc. He joined the Post Office in 1936, and worked at Dollis Hill Research Station on measurement of the arrival angles of short-wave pulses from the U.S.A. At the outbreak of war he set up and ran radio laboratories at Castleton, near Cardiff, working on v.h.f. for multi-channel telephony and television. In 1949 he returned to London to work on the planning and provision of radio links.

Peter Lowry, A.M.I.E.E., A.M.I.E.R.E., until recently assistant technical manager, television, with Rank Cintel, has joined Elliott Brothers as chief engineer of the airborne display division.

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The Prince Philip Medal of the City & Guilds of London Institute for 1964 is being presented to **Derek A. Rush,** A.M.I.E.E., C.G.I.A., engineering manager at the Basingstoke Branch of the Aviation Division of S. Smith and Sons, by His Royal Highness on March 31st at Buckingham Palace. The medal, which is awarded annually in recognition of outstanding promise or achievement in the promotion, theory or practice of science and technology, is restricted to those who have "travelled the City and Guilds path." Mr. Rush, who is 41, began his career at the Post Office Research Station, Dollis Hill, and between the years 1941 and 1946 he gained nine C. & G. certificates in telecommunication subjects. He was

D. A. Rush

awarded the City and Guilds Insignia Award in Technology (C.G.I.A.) in the field of electronic equipment in 1959. He entered industry in 1946 and was for three years with Sperry Gyroscope before going to Sydney in 1951 to join Amalgamated Wireless Australasia. He later returned to Sperry where he was concerned with gunfire control systems. He joined Smith's in 1955 as project officer for guided weapons.

W. A. Penkman, who has been in charge of the Marconi International Marine Company's service organization since 1953, latterly as service and supplies manager, has been appointed to the new post of equipment controller. Mr. Penkman began his career with the company's shore staff in 1918. Two years later he joined the sea-going staff as a radio operator. He then joined the Radio Communication Company which in 1928 was amalgamated with Marconi Marine and he rejoined his original company. He became deputy manager of the service division in 1952. The new service and supplies manager is **J. S. E. Riddle** who has been with the company since 1940. He was a sea-going radio officer for six years. In 1956 he became an inspector and later was marine manager of the company's Norwegian associates, Norsk Marconi-kompani. He has been manager, service department, at Chelmsford since last August.

Professor T. Kilburn, D.Sc., Ph.D., M.A., M.I.E.E., who is the first incumbent of the chair of computer engineering established at Manchester University in 1960, has been appointed a Fellow of the Royal Society "for his contributions to the development, design and engineering of electronic digital computers and high speed computer components." Dr. Kilburn was at the Telecommunications Research Establishment (now R.R.E.), Malvern, from 1942 until 1946 when he joined the staff at the University as reader in electronics. In collaboration with Professor F. C. Williams, head of the Electrical Engineering Laboratories, he built the University's first computer.

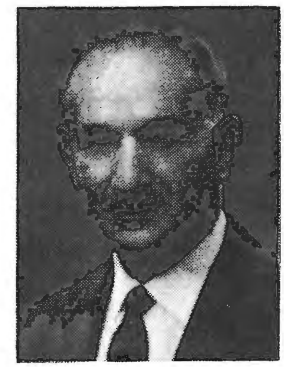
J. R. Tillman, B.Sc., Ph.D., A.M.I.E.E., has been appointed deputy director of research at the Post Office Research Station, Dollis Hill. Dr. Tillman was a Beit Research Fellow, 1934-36, and with P. B. Moon discovered the thermal neutron and the selective absorption of slow neutrons. He joined the Post Office Research Station in 1936. Dr. Tillman has latterly concentrated on solid state research and on the reliability of transistors for submarine cable repeaters. He is joint author with F. F. Roberts of the book "Theory and practice of the transistor."

Robert Telford, B.A.(Cantab.), M.I.E.E., the new chairman of the Electronic Engineering Association, joined Marconi's in 1937 at the age of 22 as a management trainee and in 1940 became manager of the Hackbridge Works where he was responsible for the production of airborne and portable radio equipment. He was appointed managing director of Marconi Brasilera in 1946 and on his return to this country four years later became assistant to the general manager at Chelmsford. He was appointed general manager of the company in 1961 and has been a director since 1963.

Charles A. R. Pearce, M.Sc., M.I.E.E., has been appointed deputy managing director of Ericsson/Etelco a principal operating company of the Plessey Group. Mr. Pearce joined Ericsson/Etelco in 1958 as controller of engineering. His earlier experience included engineering development and research with D.S.I.R. and with the London Telecommunications Region of the G.P.O. He was chief factories engineer to the Post Office from 1948 to 1951. Mr. Pearce, who is 53, received his technical education at the City and Guilds Engineering College and London University.

Richard C. Norwood, who has been deputy to the managing director of A. C. Cossor since February last year, has been appointed a managing director. **Professor C. L. Calosi,** who has been a managing director since January, 1964, has relinquished his appointment, but will continue as a director of the company in addition to his vice-presidency of Raytheon Company.

H. S. Payman, B.Sc.Tech., B.Sc. (Eng.), M.I.E.E., A.Inst.P., managing director of B. & R. Relays, has been co-opted a director of the parent company, Gas Purification & Chemical Co. Ltd. Mr. Payman, who is a graduate



H. S. Payman

of both Manchester and London Universities, joined B. & R. Relays in 1958, having been general manager of Suflex for the previous three years. Earlier he was with A.B. Metal Products as deputy director of component production.

R. H. W. Burkett, B.Sc., M.I.E.E., has been appointed managing director of Welwyn Electric Ltd. Mr. Burkett, who has been 19 years with Welwyn, was appointed to the board as technical director in 1958 and has been general manager since December, 1963.

OUR AUTHORS

G. F. Turnbull, M.Sc., and **J. M. Townsend,** M.Sc., who describe a pulse width modulated amplifier in this issue, are both on the staff of the electrical engineering laboratories of Manchester University. Mr. Turnbull graduated at the University in 1959 and did a year's post-graduate research obtaining his masterate in 1960. He was appointed assistant lecturer in electrical engineering in 1961 and was promoted to lecturer the following year. Mr. Townsend graduated at the University in 1961 and after a year's research was appointed assistant lecturer. He obtained his M.Sc. in 1963.

J. M. Firth, author of the article on an audio warning circuit in this issue, has recently gone to Canada to work with RCA Victor on the scientific satellite which is to succeed *Allouette.* After reading mechanical sciences at Cambridge from 1954-58 he spent three years with Smith's Aircraft Instruments, Cheltenham. From 1961 until last year he worked for the Radio Astronomy Group at the Cavendish Laboratory, Cambridge, on equipment for the scientific experiments included in the UK-2 satellite. This work took him to Washington for 15 months.

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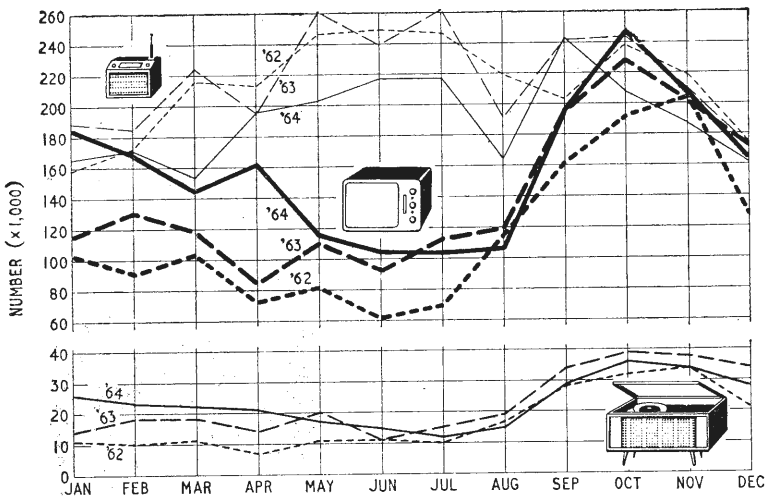
NEWS FROM INDUSTRY



Manufacturers' Despatches to the Home Market for the past three years are shown above. This graph was compiled from monthly figures issued by the British Radio Equipment Manufacturers' Association. They are net figures of deliveries by manufacturers to the home market and include those despatched to the specialist rental and relay companies. Car radios are included in the sound receiver curves.

Plessey Buy Part of Decca.—Agreement has been reached whereby the ground radar and data handling divisions of Decca Radar Ltd. at the Isle of Wight and Tolworth are to be transferred to the Plessey Company at the end of March. This transfer, which is to cost Plessey approximately £4M—payable in cash—does not include any trade mark rights and there are no restraints on the future activities of either company.

Audio Fidelity Ltd.—Radio Supply Co. (Leeds) Ltd., which was incorporated as a private limited company in 1952 and has had several changes in name in recent years, is in future to be known as Audio Fidelity Ltd. It is also announced that the company has made application to the London Stock Exchange for permission to deal in, and for quotation of all their Ordinary Shares. Audio Fidelity Ltd. have a controlling interest (75%) in Fane Acoustics Ltd., the manufacturers of audio equipment.

The **specialized components division** of the Marconi Company, which was formed in July 1962, has moved from Writtle into new headquarters at Billericay, Essex. The address is Billericay Works, Radford Crescent, Billericay, Essex. (Tel.: Billericay 3431.)

JFD Electronics Corporation, of New York, have opened a European sales office in Paris. Correspondence should be addressed to JFD Electronics, Europe SA, 7 rue de Rocroy, Paris 10.

Clarke & Smith.—Electric & Musical Instruments Ltd. have relinquished their 49% interest in the Clarke & Smith Group.

Two Million Transistor Order.—International Computers and Tabulators Ltd. have placed an order for two million silicon planar epitaxial transistors with SGS-Fairchild Ltd. These semiconductors are for use in the I.C.T. 1900 Series of computers, which were introduced last October.

Digital Airborne Data Recorder.—High accuracy recording equipment for use in the assessment trials of aircraft navigational systems has been installed in a Comet 4C belonging to the Experimental Navigation Division of the Ministry of Aviation, Aeroplane and Armament Experimental Establishment at Boscombe Down. The recorder is designed to record flight data on punched tape and will replace the photographic methods previously used by the Aeroplane and Armament Experimental Establishment.

Weymouth Radio Manufacturing Co. Ltd. is in future to be known as **Weyrad (Electronics) Ltd.** The address remains the same: Regent Factory, Weymouth, Dorset.

No Patent Infringement.—At the end of February, the Honourable Mr. Justice Lloyd-Jacobs dismissed two actions brought by AMP Incorporated, of Pennsylvania, who sought an injunction to restrain Hellermann Ltd. and Hellermann Terminals Ltd. from infringing their Letters Patent 661,192, which relates to a hand crimping tool.

Webb's Radio, of 14 Soho Street, Oxford Street, London, W.1, are discontinuing their business with effect from 31st March, 1965. They have, for many years, carried an extensive range of Eddystone receivers.

English Electric 1964 Results.—Turnover for the English Electric Group in 1964 amounted to £227M and represented an increase of £18M on the previous year's result. Group profit after tax charges of £4.8M as against £4.3M in 1963, depreciation of £4.8M (£4.4M) amounted to £6,743,000. This represents an increase of £2,948,000. The Marconi Company and its subsidiaries contributed £35.7M (£32.3M) to the Group's record turnover figure and £3M (£1.7M) to the Group's £19M pre-tax profit. More than 50% of the Company's output was exported in the year under review.

An associated company to the English Electric Group, the **Marconi International Marine Company,** reports a profit for 1964 of £734,401, which represents an increase of £65,544 over the previous year. Profit after taxation amounted to £416,145 (£315,625).

Westinghouse.—After deduction of the loss of £800,271 incurred by Gresham & Craven Ltd. (who are not in the electronics field) and general interest charges of £345,296, the group profit of the Westinghouse Brake and Signal Company for the year to 3rd October was £1,078,152. This shows a substantial improvement on the previous year when Westinghouse suffered a deficit of £863,559. Net taxation for the year under review was £220,915, leaving a profit after tax of £857,237.

Advance Electronics Ltd. group pre-tax profit for 1964 amounted to £236,347 and represents an increase of £49,128 over the 1963 result. After taxation, profits for the year totalled £121,347 as against £89,396 in 1963. This is the first financial year under the company's new name (formerly Advance Components Ltd.).

Telegraph Condenser Co.—Group trading profit of the Telegraph Condenser Company for 1964 amounted to £506,846 and shows an increase of £85,064 on the previous year's result. After deductions, including £156,335 (£156,991) for depreciation and £107,811 (£92,171) for taxation, the net profit rose from £114,323 in 1963 to £181,845.

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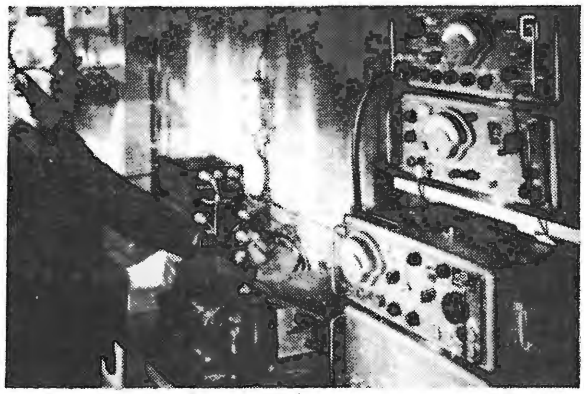
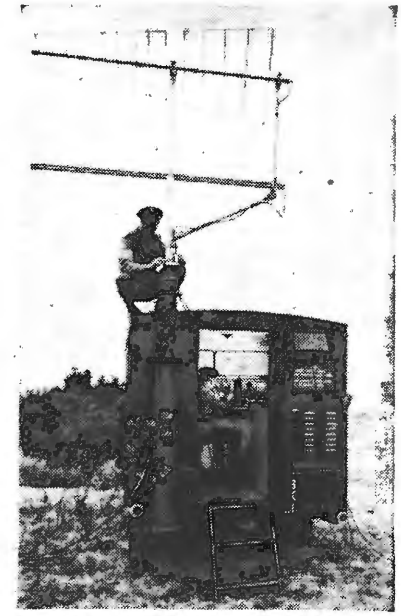


Interference.—*New screened rooms, extra staff, new equipment and facilities for on-site testing have been added to the measurement and suppression of radio interference service offered by Standard Telephones and Cables to industry. This service covers aircraft, marine and industrial equipment and installations.*

Mobile u.h.f. radio relay equipment, *known as the Type C50, which has recently been undergoing field trials, has now been accepted for use by the British Army. The equipment, which was developed as a private venture by the Automatic Telephone & Electric Company, is frequency modulated and provides six spot frequencies in the 225-400 Mc/s band. Extra channels can easily be obtained by the inclusion of a Plessey frequency synthesizer. The power rating of the transmitter is 250 watts.*



From overseas

Canada

A closed circuit television system that enables "downtown business houses" to monitor the quotation boards of the Vancouver stock exchange recently went into service. Eight cameras are used in the system, which was designed by the British Columbia Telephone Company and produced by Sylvania Electric Products Inc.; both subsidiaries of the General Telephone & Electronics Corporation.

El Salvador

G.E.C. (Telecommunications) Ltd. have received a contract, valued at £350,000, for a **microwave radio relay system** for the Central American republic of El Salvador. The system will have a capacity of 300 telephone channels, operate in the 7 Gc/s band and will connect the towns of San Miguel, Santa Ana, Sonsonate and Usulatan with the capital, San Salvador.

Finland

The Finnish Department of Telegraphs and Posts have ordered a six-target **surveillance and precision approach radar simulator,** Type SY2027, from the Solartron Electronic Group. This simulator is to be installed at Jyváskylá airfield and will be used to train air traffic controllers.

Hong Kong

Marconi Self-Tuning (MST) high-frequency **radio communications equipment** has been ordered by Cable and Wireless Ltd. for their Hong Kong transmitting station.

Pakistan

Sui Northern Gas Pipelines Ltd., of Karachi, have awarded the Marconi Company a contract, worth over £500,000, for the supply and installation of **instrumentation, telemetry and telecommunications equipment** for the first phase of a new natural gas pipeline to be laid in the northern part of West Pakistan.

Marconi Sixty Series of **airborne radio communications and navigation equipment** has been ordered for three Hawker Siddeley Trident aircraft shortly to enter service with the Pakistan International Airlines Corporation.

South America

The Bank of London & South America and English Electric-Leo-Marconi Computers Ltd. have formed a company to provide computer services in Latin America. The new company is named Intercontinental Data Services Ltd. and a KDF 8 computer will be installed in Buenos Aires at the end of this year.

Spain

Ten 13,000 ton cargo vessels now under construction in Spanish shipyards are to be fitted with Marconi Marine **navigation and communications equipment.** This order, which was placed through Empresa Nacional Radio Maritima, is valued at over £110,000.

U.S.A.

A "Certificate for Instrument Operations" approving the **Decca Navigator system** has been issued to New York Airways, who operate large passenger helicopters in and around the greater New York area. This certificate allows the Decca Navigator system to be used in all weather operations as a primary navigational aid. This is the first time that a passenger helicopter has received such a certificate for route as well as terminal area operations. The helicopter equipment consists of a dual Mark 8 installation with twin flight logs and will operate from the New York chain of Decca stations which has been in operation since January, 1958.

Agencies and agreements

The M-O Valve Company has reached a licensing agreement with the **Microwave Electronics Corporation,** of California, under which they will manufacture and market in the United Kingdom M.E.C. low-noise metal/ceramic travelling-wave tubes.

Federal Electronics, of California, have appointed Forinco Ltd., of 52 Broad Street, Worcester (Tel.: Worcester 28171), as distributors of their valves and semiconductors.

The **Telectric Corporation** have appointed Britec Ltd., of 17 Charing Cross Road, London, W.C.2 (Tel.: WHItehall 3070), to act as U.K. distributors for the aeronautical equipment they manufacture in Switzerland. It includes an automatic tester for aircraft marker beacon receivers.

High Volt Linear Ltd., of 1 Cardiff Road, Luton (Tel.: Luton 23816), now represent **Oak Ridge Technical Enterprises Corporation,** of Tennessee, who manufacture surface barrier semiconductor detectors and associated equipment for use in nuclear research.

The electronic tube division of **Westinghouse,** New York, have appointed Ad. Auriema Ltd., of 125 Gunnersbury Lane, London, W.3 (Tel.: ACOrn 8762), as U.K. distributors for their receiving valves and microwave tubes and devices.

Klein and Hummel, the West German manufacturers of audio amplifiers, tuners and studio loudspeakers, have appointed The High-Fidelity Centre, of 61 West Street, Dorking, Surrey (Tel.: Dorking 4229), to act as U.K. agents.

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Physics Exhibition

FOR the first time since the Physical Society started its series of exhibitions in 1905, this year's—the 49th—is to be held outside London. Another change is in its title which is simply "The Physics Exhibition." Now organized by the Institute of Physics and the Physical Society, which amalgamated under their joint names in 1960, this year's exhibition opens at the Manchester College of Science and Technology on April 5th for four days. Admission is by ticket obtainable free from the secretary at 47 Belgrave Square, London, S.W.1. Applicants are asked to send a stamped addressed envelope. The exhibition will be open from 10 a.m. to 8.30 p.m. (5.30 p.m. on the last day) but admission before 2 p.m. on the first day is restricted to members and invited guests.

We give below a list of the 125 exhibitors. In addition to universities, colleges, and research laboratories there are some 90 U.K. manufacturers who will be showing new instruments, apparatus and materials of special interest to physicists in their work in research, development or in teaching. We hope to give in our next issue a report of some of the more outstanding exhibits, the majority of which will be in the research or development stage.

A.W.R.E.
Admiralty
Airflow Developments
Associated Electrical Industries
Associated Engineering
Atomic Power Constructions
Automatic Telephone & Elec. Co.
Aviation, Ministry of

Baldwin Instrument Co.
Barr & Stroud
Beck, R. & J.
Bell & Howell
Birmingham University,
  Electronic & Elect'l. Eng'g. Dept.
  Physics Dept.
Boulton Paul Aircraft
Bradford Inst. of Technology
Bradley, G. & E.

Bristol Siddeley Engines
Bristol University
Brit. Nat. Com. for High Speed Photography
British Oxygen Co.
British Railways
Brunel College
Bryans

Cambridge Instrument Co.
Cambridge University
Central Office of Information
College of Aeronautics

D.S.I.R.
Data Laboratories
Dawe Instruments
Deakin Phillips Electronics
Decca Radar
Defence, Ministry of

Devices
Digital Measurements
D-mac

E.M.I. Electronics
Edwards High Vacuum
Electronic Associates
Electronic Instruments
Elliott-Automation
Enfield College of Technology
Ether Langham Thompson
Evans Electroselenium

Fairey Engineering
Ferranti
Frigistor Laboratories

General Electric Co.
Genevac
Goethean Science Foundation
Grubb, Parsons & Co.
Gulton Industries

Haigh & Hochland
Hilger & Watts

Imperial Chemical Industries
  Agricultural Div.
  Central Instrument Lab.
  Fibres Div.
  Mond Div.
  Nobel Div. (Instrument & Electronics)
  Plastics Div.
Imperial College
Industrial Instruments
Instrom
International Research & Dev. Co.
Isotope Developments

Joyce, Loebl & Co.

King's College, London

Labgear
Lan-Electronics
London Hospital Medical College

Manchester College of Science & Technology
Manchester University
Mechatronics (London)
Mercury Electronics (Scotland)
Metals Research
Microwave Instruments
Middlesex Hospital Medical School
Mullard

Nat. Inst. of Agricultural Eng'g.
Newcastle University
Newport Instruments
Nuclear Enterprises (G.B.)

Optec Reactors
Optical Works
Oxford Instrument Co.

Panax Equipment
Perkin-Elmer
Planer, G.V.
Plessey Co.
Post Office Research Station
Pye, W. G., & Co.

Rainbow Radio
Rank Nucleonics & Controls
Research Electronics
Research & Engineering Controls
Research & Industrial Instruments Co.
Research Instruments
Royal College of Advanced Technology, Salford
  Dept. of Elect'l. Eng'g.
  Dept. of Pure & Applied Physics
Royal Military College of Science

Safety in Mines Research Establ.
Sangamo Weston
Scientifica
S.E. Laboratories (Eng'g.)
Smith, S., & Sons
Solartron Electronic Group
Standard Telephones & Cables
Strathclyde University

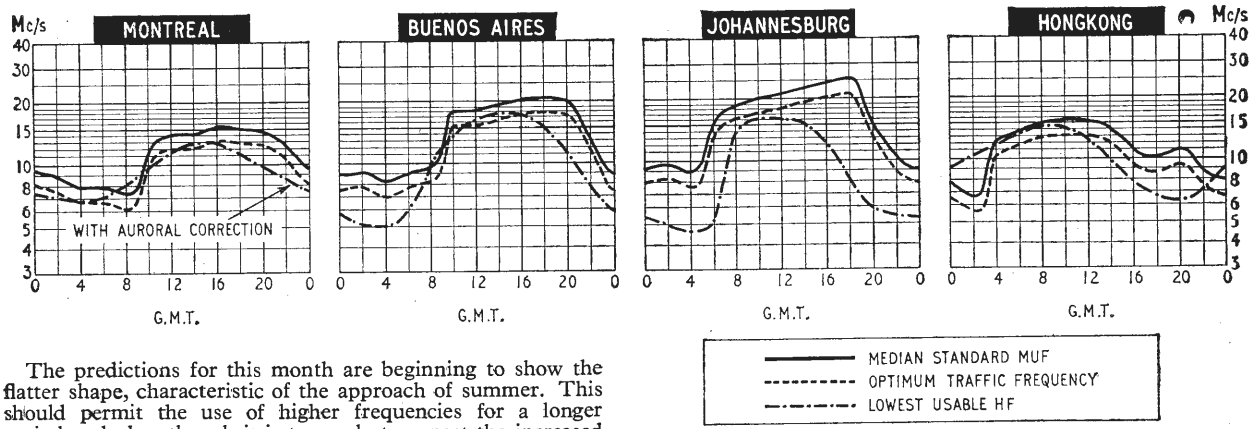
Techne (Cambridge)
Technology, Ministry of
Telequipment
Telford Products
Telsec Instruments
Tinsley, H., & Co.
20th Century Electronics

U.K.A.E.A.
Unicam Instruments
United Power Co.
University College, London

Vacuum Generators
Venner Electronics

Wareham (Measuring Systems)
Wayne Kerr Laboratories
Wild Barfield

H. F. PREDICTIONS — APRIL



The predictions for this month are beginning to show the flatter shape, characteristic of the approach of summer. This should permit the use of higher frequencies for a longer period each day, though it is too early to expect the increased sunspot number to have any effect yet. Circuit working will still prove difficult, notably on the relatively short Montreal-London route, and little advantage can be expected due to Sporadic-E ionization. The reverse path London-Montreal might prove somewhat easier, due to lower LUF.

The curves show the median standard MUF, optimum traffic frequency and the lowest usable frequency (LUF) for reception in this country. Unlike the standard MUF, the LUF is closely dependent upon such factors as transmitter power, aerials, and the type of modulation. The LUF curves shown are those drawn by Cable & Wireless Ltd. for commercial telegraphy and assume the use of transmitters with a power of several kilowatts and rhombic type aerials.

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AUDIO FAIR PREVIEW

GUIDE TO NEW EQUIPMENT EXHIBITED

ON April 22nd the International Audio Festival & Fair opens at the Hotel Russell, London, W.C.1, for four consecutive days. This preview of the Fair is compiled from information supplied by exhibitors in response to our request. Some manufacturers, however, did not wish to release information on their latest products before the opening date of the show. We hope, none the less, that in the following few pages readers will find a useful guide to most of the new equipment to be seen at the Fair.

We plan to include in our June issue our usual review of some of the outstanding exhibits seen at the Fair.

The reports are arranged alphabetically under trade names or abbreviated company title. Where, however, the trade name bears no relation to the manufacturer's name it is given in square brackets after the firm's name in the list of exhibitors below. At the end of reports on overseas companies' exhibits we give the name and address of the U.K. agents.

Plans are being made for the B.B.C. to provide demonstrations of pilot-tone stereo transmissions during the Fair. On the last day of the Fair and also on the Monday, record manufacturers are providing a series of demonstrations as well as displays of their discs at the nearby Royal Hotel.

The Fair will open each day at 11.0 but admission on the first day until 4.0 is restricted to invited guests. It will close at 9.0 (Sunday 8.0). Tickets (admitting two) are available from exhibitors, dealers or the editorial office of *Wireless World*. Please send a stamped addressed envelope.

A.D.C.

The full range of cartridges made by the Audio Dynamics Corporation is to be shown. The Point-Four and Point-Four/E cartridges will be featured in A.D.C. Pritchard tone arms fitted to Thoren Type TD 124 turntables, and the ADC-770 cartridge in a Goldring Type GL70 transcription unit.

Agents: K.E.F. Electronics Ltd., Tovil, Maidstone, Kent.

A.K.G.

In addition to their existing range of dynamic and condenser microphones a number of new types will be shown. The DX11 reverberation microphone announced last year has now reached the production stage. The D19C range has been extended with the introduction of the D119CS which incorporates a bass-cut switch and windshield. A high-low impedance switch and an on-off switch are included in the new D14S. The D77 stereo microphone has been superseded by the D66. A smaller version of the C12 condenser microphone has been introduced (the C12A) using a Nuvistor amplifier, a directional pattern switch and stabilized power unit.

Agents: Politechna (London) Ltd., Eardey House, 182 Campden Hill Road, London, W.8.

LIST OF EXHIBITORS

A K G
Acoustical Manufacturing Co. [see Quad]
Agfa
Akai
Amateur Tape Recording Magazine
Ampex Great Britain
Armstrong Audio
Audio Dynamics Corp.

BASF Chemicals
B.M.B. Sales
Bang & Olufsen
Beyer Elektrotechnische Fabrik
Boosey and Hawkes [see Jordan-Watts]
Braun
Brenell Engineering Co.
Brown, S. G.
Butoba

Celestion
Clarke & Smith Mfg. Co.

Decca Record Co.
Decca Radio & Television Co.
Derritron Radio [see Chapman]
Design Furniture
Dual Electronics A/S

E.M.I. Tape
Elcom (Northampton)

Fane Acoustics
Ferrograph Co.

Field, N. & S. B. [see Record Housing]
Fi-Cord International

G.K.D.
Garrard Engineering
Goldring Mfg. Co.
Goodmans Industries
Grampian Reproducers
Gramophone, The

Hammond, C. E., & Co.

Ilford

K.E.F. Electronics
Kelly Speakers
Kodak

Leak, H. J., & Co.
Link House Publications
Long Playing Record Library
Loewe-Opta AG
Lowther Manufacturing Co.
Lustraphone

Mallory Batteries
Mastertape (formerly MSS)
Minnesota Mining & Mfg. Co.
Mullard

Ortofon A/S

Peto-Scott
Philips Electrical
Planet Projects
Print & Press Services
Pye

Radford Electronics
Records and Recording
Reslosound
Rogers Developments
Revox-Studer A/S

S.M.E.
Saba Electronics
Scandinavian Radio & TV Cie. [see S.R.T.]
Scott, H. H. Inc.
Shure Electronics
Sonotone
Sony Corp. of Japan
Standard Telephones & Cables
Sugden & Co. [see Connoissuer]
Svenska Hogtalfabriken [see S.H.B.]

Tandbergs Radiofabrik A-S
Tannoy Products
Telefunken
Thorens, S.A.
Trio
Truvox

Vortexion

Wharfedale Wireless Works
Whiteley Electrical Radio Co.
Williman, K. H., & Co.
Wilmex
Wilson Stereo Library
Wireless World & Wireless Trader

AGFA

The complete range of Agfa magnetic recording tapes is to be shown, including the Novodur library storage cassette, which is available with several different size reels as an alternative to the more usual swivel type cassettes.

Agfa Ltd., 27 Regent Street, London, S.W.1.

AKAI

Pullin Photographic, now part of the Rank Audio Visual Aids Division, will be displaying four new Japanese Akai tape recorders. All models are suitable for stereo operation and incorporate some novel features. The M-8 and X-4 (illustrated) use a cross-field head which results in higher frequency response at low tape speeds. The M-8 also includes a vertically directed supplementary loudspeaker system. The ST-1, being shown for the first time in this country, is a two-speed portable model with a transistor pre-amplifier. Other exhibits include the 345 recorder and the SS-110 stereo loudspeaker system.

Agents: Pullin Photographic, 11 Aintree Road, Perivale, Middlesex.

AMPEX

A new magnetic tape recording equipment on show will be the MR-70, for making master recordings. The main advances over previous designs are a 10dB improvement in signal/noise ratio, to take advantage of low-noise tapes now available, a better frequency response and improved control of tape motion. Domestic tape recorders to be seen will include the 2,000 Series which feature automatic threading, automatic reverse, automatic shut-off and ability to operate in horizontal or vertical positions.

Ampex Great Britain Ltd., 72 Berkeley Avenue, Reading, Berkshire.

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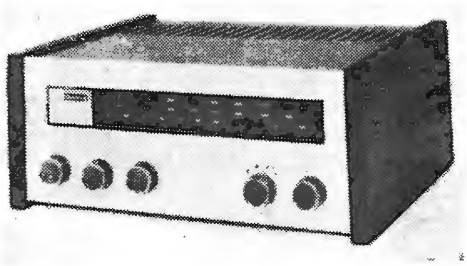
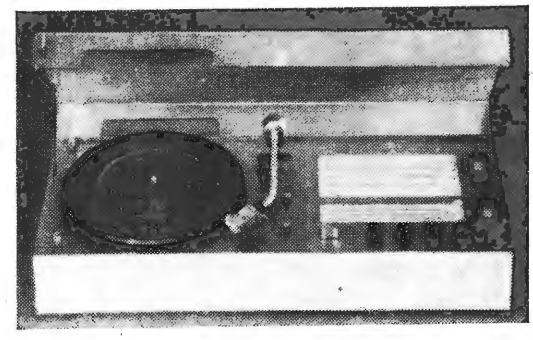
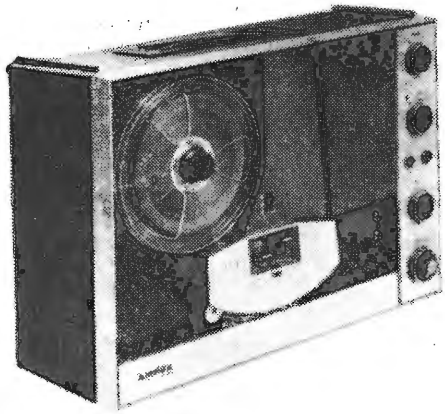


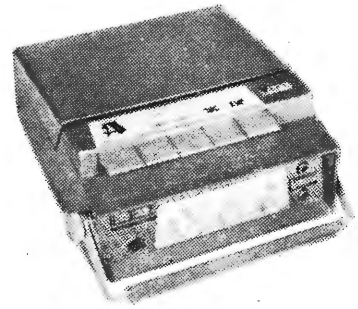
Armstrong 127M tuner-amplifier.



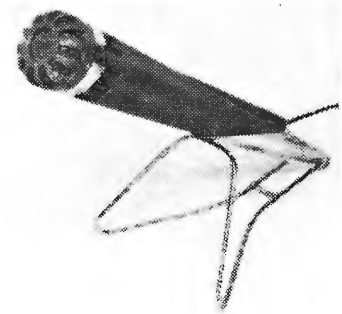
Braun Audio 2 Hi-Fi Stereo Combination.



Ampex Model 2000 tape recorder.



Akai X-4 battery/mains tape recorder with cross-field head.



Dual function microphone by S. G Brown.

ARMSTRONG

Designed for users requiring lower power outputs (5 watts) than those provided in the main Armstrong range are the 127 stereo tuner-amplifier and the 127M mono tuner-amplifier. Each unit will receive a.m. and f.m. broadcasts and can be used as an amplifier for tape recording or for reproducing records. The stereo model has provision for addition of a multiplex decoder for reception of f.m. stereo broadcasts.

Armstrong Audio Ltd., Warlters Road, London, N.7.

BASF

Visitors will be invited to listen to tape recorded talks on subjects of their own choice, and at the same time copy tapes will be made for them to take away free. Details of the range of BASF tapes, library boxes, spools and other accessories will be available. The company makes tapes with playing times up to 90 minutes at 7½ ins/sec (and correspondingly for lower speeds).

BASF Chemicals Ltd., 5a Gillespie Road, London, N.5.

B.M.B.

More than 70 types of sapphire and diamond styli will be exhibited for the first time by B.M.B. (Sales) Ltd. These are manufactured by the Stylus Division of British Manufactured Bearings Company.

B.M.B. (Sales) Ltd., Crawley, Sussex.

BANG & OLUFSEN

A wide range of B. & O. equipment is available in this country. It includes portable and table radios, stereograms, tape recorders, record players and accessories—from pickup cartridges to loudspeaker units.

Agents: Debenhams Electrical & Radio Distribution Company, Eastbrook Road, Eastern Avenue, Gloucester.

BEYER

A number of new microphones manufactured by Beyer Elektrotechnische Fabrik are to be shown. This includes the Beyer M 80 cardioid with a frequency response of 50 to 16,000 c/s and the Type M 110 dynamic directional microphone with a frequency response of 60 to 12,000 c/s.

Agents: Fi-Cord International Ltd., 40a Dover Street, London, W.1.

BRAUN

Reception of f.m. stereo broadcasts and medium-, long- and short-wave stations, as well as mono and stereo reproduction of disc and tape records, is provided for in the transistorized Audio 2 Hi-Fi Stereo Combination. Two other recent introductions will be the PS 400 stereo record player with counterbalanced tubular pickup arm and lowering system, and the CE 16 tuner covering f.m. stereo and m.w. broadcasts.

Agents: Argelane Ltd., 251 Brompton Road, London, S.W.3.

BRENELL

The well-known Mark 5 range of equipment is now into Series 3 and includes a tape deck, amplifier and tape recorder. These will be on show together with the Type M tape recorder, which has separate record and playback heads and amplifiers, and the Mark 510 recorder which will accommodate reels up to 10½in dia. A stereo tape recorder (STB/5/2) will also be on view, with a monitor amplifier and loudspeakers as optional extras.

Brenell Engineering Co. Ltd., 231 Liverpool Road, London, N.1.

BROWN

Most audio products will be demonstrated, including the new dual function microphone (illustrated) which is transformed into a differential microphone by operation of a shutter. The Universal handset will be shown, with built-in pre-amplifier, as used for communication in aircraft. The recently announced miniature headset, developed for use in Mercury space craft, will also be on view.

S. G. Brown Ltd., King George's Avenue, Watford, Herts.

BUTOBA

The latest tape recorder to be introduced is the three-speed portable model MT22. It has remotely controlled rewind and pause, a digital tape counter, an automatic tape stop, a recording level meter,

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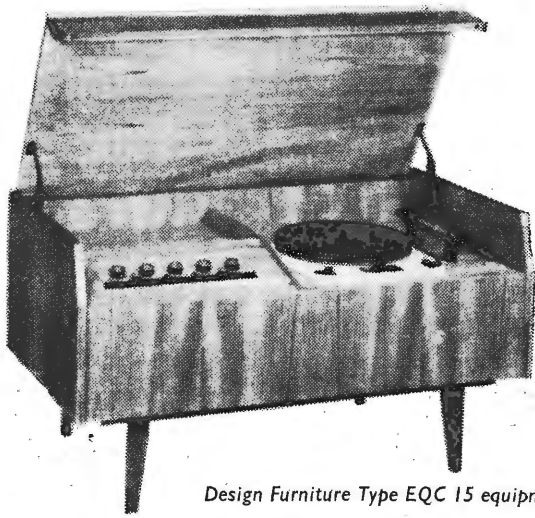
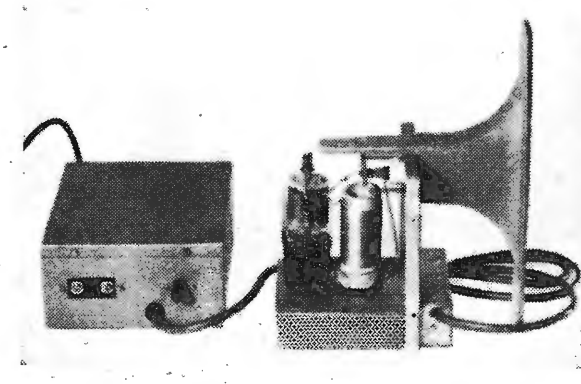


Design Furniture Type EQC 15 equipment cabinet.



Fane Acoustics "Ionofane" loudspeaker.

a 7-inch circular loudspeaker and transistor electronic circuits. Also on show will be the MT5 recorder, notable for its robust construction.

Agents: Denham & Morley, 173/175 *Cleveland Street, London, W.*1.

CELESTION

The new Ditton 10 wide-range loudspeaker system with a power handling capacity of 10 watts r.m.s. will be featured together with existing models CX1512 and CX2012.

Celestion Ltd., Ferry Works, Thames Ditton, Surrey.

CHAPMAN

The range of tuners to be shown includes an f.m. model; an a.m./f.m. type giving also long, medium and short wavebands; an a.m. bandspread receiver covering the 11, 13, 16, 19, 25 and 31 metre bands in bandspread ranges; and a similar bandspread receiver covering also f.m. at 87.5-108 Mc/s.

Amplifiers on view will include the 306 Stereo, an 8+8 watt integrated equipment with a frequency response claimed to be flat within 0.2dB from 30 c/s to 20 kc/s. Inputs are selected by push-button switches.

Derritron Radio Ltd., 24 *Upper Brook Street, London, W.*1.

CLARKE & SMITH

Although no details of the exhibits to be shown by this firm were available at the time of going to press it is reasonable to assume that they will include high-quality amplifiers and sound reproducing equipment.

Clarke & Smith Manufacturing Co. Ltd., Melbourne Road, Wallington, Surrey.

CONNOISSEUR

Two transcription turntables in the Connoisseur Craftsman series (one a two-speed and the other a variable three-speed unit) are to be shown by the manufacturers—Sugden. The units are very similar and have identical wow (0.15%) and flutter (0.1%) characteristics. Hum level is less than 80 dB and rumble is 50dB down on both machines. The Craftsman series of loudspeaker enclosures, which are available with and without speakers, and a selection of pickup arms and cartridges are also to be shown.

A. R. Sugden & Co. (Engineers) Ltd., Market Street, Brighouse, Yorkshire.

DECCA

The *ffss* Mark III pickup will be demonstrated with a new magnetic bias adjuster. This fits on to the pivot pillar of all Decca pickup arms and magnetically neutralizes the lateral bias force. A new *ffss* Deccadec includes a non-ferrous turntable and a pickup arm to take all *ffss* heads except those with elliptical stylus. The current TSA range of "budget stereo" equipment will also be demonstrated, including the TSA33 transistor stereo amplifier and the Deccadec with the Deram ceramic cartridge.

*Decca Radio & Television Ltd., Albert Embankment, London S.E.*1.

DESIGN FURNITURE

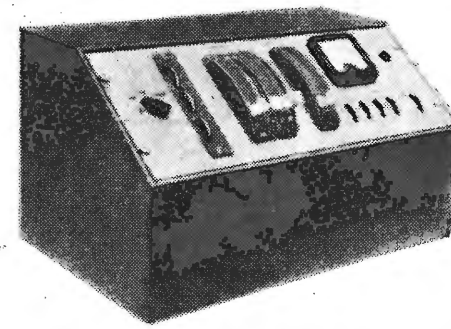
Two new equipment cabinets with motor mounting boards that are adjustable in height are to be featured. The motor mounting board in the larger of the two cabinets, the EQC 14, can be stepped in height if required. A record storage cabinet and a loudspeaker enclosure, containing Celestion speakers, are also to be featured.

Design Furniture Ltd., Calthorpe Manor, Banbury, Oxon.

DUAL

Of this range of German equipment, the 1009 turntable and pickup arm will be shown with the CV2 transistor integrated stereo amplifier and loudspeaker unit CL3. The 1009 turntable, which weighs 7½ pounds, has a fine speed control which uses a conical motor drive pulley. The tracking weight is adjustable and, incidentally, it is claimed that the pickup will track with a tilt of 45° and a tracking weight of 1 gram. The unit provides for automation operation with a tracking weight of ½ gram.

*Agents: Celsa Electric Company Ltd., Kelway Place, London W.*14.



Elcom transistorized sound studio unit.

E.M.I.

In addition to showing current tape recorders, EMI Electronics will present their new L4 portable professional recorder. This two-speed model with remote control and mixing facility includes a fourth magnetic head for sound sync. EMI Tape Ltd. will also be showing their range of recording tapes, film and blank discs.

EMI Electronics, Hayes, Middlesex.

ELCOM

Transistorized sound equipment for recording and broadcasting studios will be displayed. The units are available in portable or console form and facilities include input switching, tone equalization, channel and group fading by quadrant faders, mid-lift units and pre-fade listen. Separate modules, available as plug-in units, will include line amplifiers, microphone amplifiers, compensating units, faders and peak programme meter units.

Elcom (Northampton) Ltd., Weedon Road, Industrial Estate, Northampton.

FANE

The new Ionophone loudspeakers should create much interest since they have no mechanical moving parts and

(*Continued on page* 189)

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Duette equipment cabinet from GKD which can be used as a room divider.

use ionized air to propagate sound. The Ionofane 601 frequency response extends from 3 kc/s-30 kc/s and is claimed to have a better transient response than conventional loudspeakers. The 602 model includes the 601 unit and a mid-range unit, and in the 603 model a 15in bass unit is added to the 602.

Fane Acoustics Ltd., Hick Lane, Batley, Yorkshire.

FERROGRAPH

An addition to the range of well-known equipment will be shown, but at the time of going to press details had not been released.

The Ferrograph Company Ltd., 84 *Blackfriars Road, London S.E.*1.

FI-CORD

A new tape recorder, the Fi-Cord 202A, is to be introduced at the Fair. This machine is to replace the 202, which was first seen three years ago. At the higher of the two speeds ($7\frac{1}{2}$ in/sec) the frequency response of this portable machine is quoted to be within 3 dB from 50 to 12,000 c/s. Other features include a re-designed control panel and a new Vu-meter. Fi-Cord will also be showing the first two microphones of their own make. Both are of studio quality and use the moving coil principle.

Fi-Cord International Ltd., 40*a Dover Street, London, W.*1.

GKD

The Huntingdon and Anglian series of cabinets have been completely redesigned and will now accommodate almost any manufacturer's equipment. A number of modifications have also been made to the remainder of the G K D range, but without change to styling.

G K D Ltd., 74 *Langley Street, Luton, Beds.*

GARRARD

In addition to the present range of products, the new Model SP25 single-disc player will be displayed. This unit has a calibrated stylus pressure adjustment, a bias compensator and a pickup arm lowering device. An unusual feature for a single player is the automatic arm return. The unit also has a balanced non-magnetic die-cast turntable with a dynamically balanced rotor.

Garrard Engineering Ltd., Swindon, Wilts.

GOLDRING

A four-speed turntable unit with a fine speed adjustment of ± 10% on each speed will be introduced. Designated G 66, the unit has a built-in lowering device coupled with the on/off switch, and the pickup arm is wired for stereo. The idler wheel is automatically disengaged as the unit is switched off. Also on show will be the Pickering V 15 cartridge and a range of three transcription units, GL58, GL70 and GL88.

Goldring Manufacturing Co. (Gt. Britain) Ltd., 486-488 *High Road, Leytonstone, London, E.*11.

GOODMANS

Loudspeakers from eight to eighteen-inches in diameter are to be shown. Included in the selection of high-fidelity speakers is to be the 12-in Axiom which incorporates several new design features, such as a new pressure die-cast chassis. The small Maxim reproducer ($10\frac{1}{2} \times 5\frac{1}{2} \times 7\frac{1}{4}$in), which was introduced at last year's festival is also to be shown.

Goodmans Industries Ltd., Axiom Works, Lancelot Road, Wembley, Middx.

GRAMPIAN

A selection of their range of microphones, amplifiers and loudspeakers will be shown, including three new amplifiers and a new 12in loudspeaker.

Grampian Reproducers Ltd., Hanworth Trading Estate, Feltham, Middlesex.

HAMMOND

A custom built sound system will be introduced, containing an a.m./f.m. tuner with stereo decoder, a stereo amplifier giving 12 watts per channel, a Garrard A70 transcription turntable with magnetic cartridge, and loudspeakers. A new condenser microphone, a redesign of the Microkit model, includes an encapsulated pre-amplifier, balanced low-impedance output and a regulated power supply. Also new are two loudspeaker units, the Europa with four drive units and the L.7 with a double-cone wide-range loudspeaker.

C. E. Hammond & Co. Ltd., 90 *High Street, Windsor, Berks.*

ILFORD

Zonatape magnetic recording tape, which is specially manufactured for amateur tape recording, is to be shown. It is available in several grades on spools up to $8\frac{1}{4}$in diameter, which are colour-coded to indicate the grade of tape. Diacetate, p.v.c. and polyester based tapes are featured in the Zonatape range.

Ilford Ltd., Ilford, Essex.

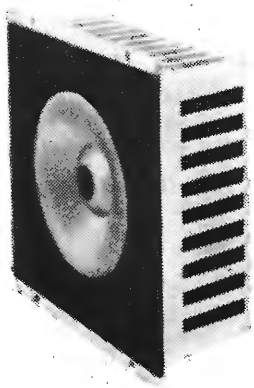
JORDAN-WATTS

Five examples of the Jordan-Watts modular loudspeaker design will be demonstrated. The Mini 12, with a single module, has a power handling capacity of 12 watts and a frequency response claimed to be level down to 80 c/s. The A 12, also one module, has a response level down to 40 c/s. A more advanced domestic system is the A 25, in which the radiation pattern is tailored to reduce spurious effects of room acoustics. The B50 is similar in performance but has four modules in distributed line source array and handles 50 W. Radiation pattern control techniques used in the A 25 and B 50 are adapted in the DPS 100 to provide a more precise stereo image.

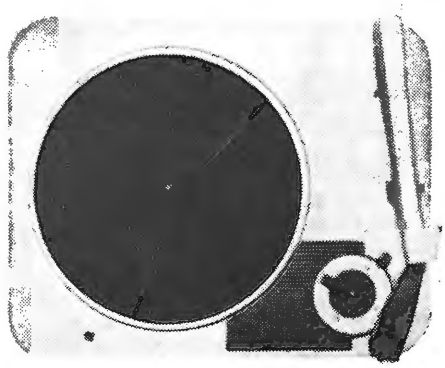
Boosey & Hawkes (Sales) Ltd., Sonorous Works, Deansbrook Road, Edgware, Middlesex.

KEF ELECTRONICS

The T.15 tweeter unit has been redesigned and is now claimed to provide an additional octave at the top end of its frequency response and a smoother response over its whole range. Floor-mounted and suspended versions of the B.B.C. monitoring loudspeakers will be



Jordan-Watts modular loudspeaker.



Goldring Model G66 turntable unit.

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demonstrated. The company will also introduce a loudspeaker system in an 0.8 cu.ft cabinet which they say comes half-way between their existing Celeste and Duette models. This is their contribution to the Group 4 venture, which aims to offer genuine hi-fi equipment in attractive cabinets.

KEF Electronics Ltd., Tovil, Maidstone, Kent.

KELLY

Kelly loudspeakers (now marketed by Decca) will include an improved version of the well-known Mini and a larger enclosure operated with an "acoustic lens" high-frequency diffusion technique. The Mini loudspeaker will be demonstrated in conjunction with the latest turntable unit, the *ffss* Deccadec, which has a magnetic pickup, a pickup arm extension/adaptor with standard *ffss* head fitting and a non-ferrous turntable.

Decca Record Co. Ltd., 9 Albert Embankment, London S.E.1.

KODAK

A wide range of sound recording tapes are to be featured, including the Kodak P.400 quadruple-play tape which is claimed to be particularly good at slow speeds. This tape is now available on 3-, 3¼- and 4-in spools.

Kodak Ltd., Kodak House, Kingsway, London, W.C.2.

L.P. RECORD LIBRARY

The Long Playing Record Library will be publishing volume 3(1) of its "Guide to the Bargain Classics" and also a new edition of its "Classical Catalogue & Handbook" specially for the Fair. Details will also be available of the Professional Stereo Record Library.

The Long Playing Record Library Ltd., Squires Gate Station Approach, Blackpool, Lancs.

LEAK

Demonstrations of the Stereo 30 two-channel transistor amplifier together with the Sandwich loudspeaker system will be given. In the amplifier, the power section following the tone control pre-amplifier in each channel is a directly coupled transformerless push-pull circuit with over 60 dB of negative feedback, giving an output of 10 watts into a 15-Ω load or 15 watts into a 4-Ω load. The Sandwich loudspeaker system comprises a treble unit and a bass unit, both with rigid, light-weight cones to give improved piston action and freedom from cone break-up. The cone is constructed as a "sandwich" of two skins of thin aluminium enclosing a ⅜-in thick core of light expanded plastics material.

H. J. Leak & Co. Ltd., Brunel Road, Westway Factory Estate, London, W.3.

LOEWE-OPTA

Receivers, radiograms and tape recorders will be exhibited, including the recently announced Optacord 408 tape recorder. The two-speed Optacord 416 will be on display for the first time in this country.

Agents: Highgate Acoustics, 71 Great Portland Street, London, W.1.

LOWTHER

This company is well known for its range of loudspeakers using a single high-flux twin-cone drive unit in a horn-loaded enclosure. These include the Acousta folded-horn enclosure (14in × 18in × 33in); corner reproducers; and a twin enclosure for stereo reproduction. A feature of the drive unit is a central stabilizer plug which spreads the high frequency radiation and provides horn loading of the inner cone, thereby smoothing the response. Also on view will be the company's range of power amplifiers, control units and f.m. tuners, and a battery-powered a.f. test oscillator for setting up sound reproducing equipment.

The Lowther Manufacturing Company, Lowther House, St. Mark's Road, Bromley, Kent.

LUSTRAPHONE

A wide range of microphones including dual-head stereo types, studio ribbon velocity microphones and moving-coil units, will be displayed together with floor and table stands, booms, flexible positioning tubes and other accessories. A folding mobile floor stand is a new addition to the range.

Also on show will be a microphone and radio transmitter combination, called the Radiomic System, which has received Post Office type and specification approval. Single- and multi-channel receivers are available for the system.

Lustraphone Ltd., St. George's Works, Regent's Park Road, London, N.W.1.

3M

All "Scotch" magnetic tapes to be shown, excluding the acetate-based standard type, will have the recently introduced Superlife protective coating, claimed to increase tape life up to fifteen times. Also displayed will be a tape machine that records and plays tapes in cartridge form, both mono and stereo. Up to 20 tape cartridges may be stacked on the loading platform, giving up to 15 hours playing time. Recording, replaying and cartridge changing are all automatic. Accessories on show will include a self-threading reel.

Minnesota Mining & Manufacturing Co. Ltd., 3M House, Wigmore Street, London, W.1.

MALLORY

The full range of cells and batteries of particular value in audio equipment will be displayed. The 1.5V manganese-alkaline dry cells have been improved to give a lower internal impedance.

Mallory Batteries Ltd., Crawley, Sussex.

MASTERTAPE

Four grades of magnetic recording tape are featured. These are available on five reel sizes—from 3 to 7 in—and are to be shown with a new splicing kit and a wide range of accessories for the recordist. Other items to be featured include the "Min-voice letter" and the "Senda-message" ultra-lightweight postal pack on a miniature reel.

Mastertape (Magnetic) Ltd. [formerly MSS Recording Co.], Poyle Trading Estate, Colnbrook, Slough, Bucks.

MULLARD

Valves, capacitors, new transistor equipment circuits and the new range of transistors will be shown. The range of transistors comprises complementary output pairs: the AD128/AC176 for 3 watt class B stages and the AD161/AD162 for 6 watt stages. The AD149 can give 5 watts class A and is supplied in matched pairs for higher power stages. Also shown is a silicon planar epitaxial transistor, BC107, for high gain, low noise input stages and pre-amplifiers.

Mullard Ltd., Torrington Place, London W.C.1.

ORTOFON

A stereo moving-coil pickup cartridge with the high compliance of 10×10^{-6} cm/dyne and an equivalent mass at the stylus point of 1 mgm will be exhibited. Without a transformer (type SPU) it weighs 8gm, and has an impedance of 2Ω and an output of 0.05 mV/cm/sec. With a transformer (type SPU-T) it has an output impedance of 15kΩ and an output of 2 mV/cm/sec. The stylus is diamond and three versions are available—for stereo only, for stereo/mono, and elliptical-point for stereo/mono.

Agents:—Metro-Sound (Sales) Ltd., Bridge Works, Wallace Road, Canonbury, London, N.1.

PETO SCOTT

The range of Philips professional sound recording equipment is to be shown this year, along with a new video tape recorder, Type EL 3400.

Peto Scott Electrical Instruments Ltd., Addlestone Road, Weybridge, Surrey.

PHILIPS

A variety of tape recorders and accessories will be shown, including a four-speed stereo model (EL3534) and the cartridge loading model (EL 3300). Other models to be shown are EL 3548, EL 3549 and EL 3552.

Philips Electrical Ltd., Century House, Shaftesbury Ave., London, W.C.

PLANET PROJECTS

A continuously operating magnetic tape transport mechanism, type C.D.2, will be shown. Designed to provide continuous music, the mechanism automatically reverses when the end of either reel is reached and electrically selects the appropriate one of the two heads. Using standard ¼-inch tape, it operates at either 1⅞ in/sec or 3¾ in/sec and is available for ½ or ¼ track mono replay or stereo replay only. The deck accepts 7-inch reels (or smaller if required) and the normal international recording direction is used.

Planet Projects Ltd., Goodman Works, Belvue Road, Northolt, Middx.

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PYE

A transistorized version of the well known "Black Box" mono record reproducer is to be shown along with the "Achoic Box" stereo record reproducer which was first seen at last year's Radio Show. The current range of "Brahms" hi-fi equipment, which is available either as a complete unit or separate chassis, will also be shown.

Pye Ltd., Radio Works, Cambridge.

QUAD

A multiplex decoder for reception of stereophonic broadcasts on the pilot-tone system is now available, but for export only at present. Designed for use with the Quad f.m. tuner and Quad 22 control unit, the unit recovers the stereo information signal (difference between left- and right-hand channels) and combines it with the sum signal, so that the original two channels are obtained separately.

In addition, the well-known range of power amplifier, control unit, a.m. and f.m. tuners and electrostatic loudspeakers will be displayed.

The Acoustical Manufacturing Co. Ltd., Huntingdon.

RADFORD

Items on show this year include the Series 3 Super Bookshelf loudspeaker unit with a response of 80 c/s—14 kc/s ± 3½ dB and handling up to 25 watts r.m.s. A new transistor control unit will be on display—the SC22—and f.m. tuners will be introduced with facilities for interstation noise suppression and multiplex stereo output. If the B.B.C. multiplex stereo transmissions are suitably timed it is hoped to demonstrate the stereo f.m. tuner. Other established Radford items will also be shown.

Radford Electronics Ltd., Ashton Vale Estate, Bristol 3.

RECORD HOUSING

Most of the range of 20 cabinets will be on show, including the new Hi-Flex units which can be placed together, vertically or horizontally, to form a continuous cabinet. The system comprises an equipment unit, a record unit and a 12 in loudspeaker unit. The Nordyk range has been extended to include a Hi-Rak which is used for a shelf-mounting system. Changes in style have been made to the Lowflex and the Lowline-Two—both will be on show.

N. & S. B. Field & Co., Brook Road, London, N.22.

RESLOSOUND

The complete range of Relso ribbon and dynamic microphones are to be shown with a comprehensive range of accessories, including floor-stands, table-stands, adaptors, etc.

Reslosound Ltd., 24 Upper Brook Street, London, W.1.

REVOX

The model 736 stereo tape recorder, exhibited at last year's Audio Fair, will be on show. This two-speed model accepts up to 10½-in spools and incorporates equalization time-constants to the latest C.C.I.R. standard of 70 μsec and 140 μsec. An automatic transparency projector unit—the Slide-o-Matic—will be demonstrated working in conjunction with the Revox tape recorder.

Agents: C. E. Hammond & Co. Ltd., 90 High Street, Windsor, Berks.

ROGERS

The latest version of the "eighty-eight" stereo amplifier and an f.m. receiver are to be shown for the first time. The receiver covers the frequency range 88 to 108 Mc/s and has a sensitivity of 1.5 μV. Other items to be shown include several amplifiers, f.m. tuners, speaker systems and equipment cabinets.

Rogers Developments (Electronics) Ltd., 4-14 Barmeston Road, Catford, London, S.E.6.

S.R.T.

Two transcription units and a record player made by the Scandinavian Radio & Television Company are to be shown. An eight-inch diameter speaker, driven by a 2.5-watt amplifier, is incorporated in the four-speed record player. Distortion is claimed to be less than 1% at 2.5 watts. The transcription units also have four speeds and one is fitted with transistor pre-amplifiers.

Agents: Denham & Morley Ltd., Denmore House, 173-175 Cleveland Street, London, W.1.

S.H.B.

Loudspeaker units manufactured by Svenska Hogtalfabriken are to be shown. These units are quite small (i.e. a unit of 10×5¾×7 in has a power handling capacity of 8 watts undistorted) and are hermetically sealed.

Agents: Metro-Sound (Sales) Ltd., Bridge Works, Wallace Road, Canonbury, London, N.1.

S.M.E.

The Series II range of precision pickup arms and accessories will be on view, and a new addition this year will be a light-weight stainless steel lifting handle.

S.M.E. Ltd., Steyning, Sussex.

S.T.C.

Two new microphones are to be shown by Standard Telephones and Cables. A field effect transistor head amplifier is incorporated in the Type 4126 capacitor microphone. The price of this unit, which is also available with a cardioid insert, is around £120. The other new microphone, Type 4119, is a tubular unit with a ribbon insert that has narrow cardioid characteristics. It has a spherical woven-wire windshield and a tubular bass chamber. A novel collapsible microphone floor stand is to be shown.

Standard Telephones and Cables Ltd., 29-30 Glasshouse Yard, Aldersgate Street, London E.C.1.

SABA

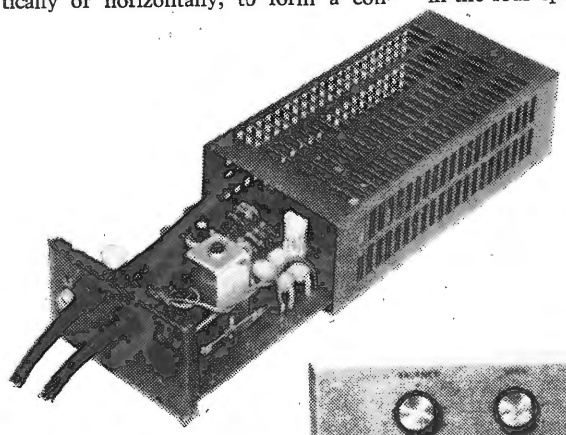
Two tuner amplifiers will be shown for the first time, the Stereo Studio T II with 24 watts output and the Stereo Studio T III with bandspreading, automatic tuning and 70 watts output. Both are transistorized and cover long-, medium- and short-wave and v.h.f./f.m. bands. Also on show will be the TK 230s stereo tape recorder, incorporating two loudspeakers.

Saba Electronics Ltd., Eden Grove, Holloway, London, N.7.

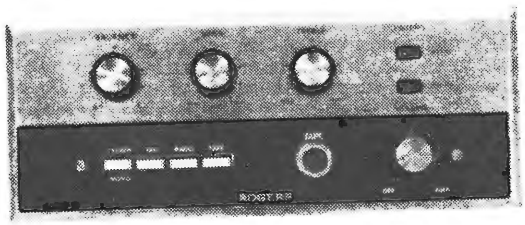
SCOTT

The American company H. H. Scott will be exhibiting their 299 stereo valve amplifier, rated at 32 watts r.m.s. per channel at 0.8% harmonic distortion with a bandwidth of 20 c/s-20 kc/s ± 1 dB. This amplifier can also drive a third centre loudspeaker, the signal being derived from both left and right channels. Two new amplifiers will be on show this year for the first time, the model 200 rated at 12 watts r.m.s. per channel at 0.8% harmonic distortion (I.H.F.M. power band: 25 c/s—15 kc/s) with the derived centre channel and the model 260, a solid state design with silicon-output transistors and rated at 30 watts per channel.

Agents: A. C. Farnell Ltd., Hereford House, North Court, Vicar Lane, Leeds.



Quad multiplex decoder for stereo reception.



Rogers Cadet III stereo amplifier and control unit.

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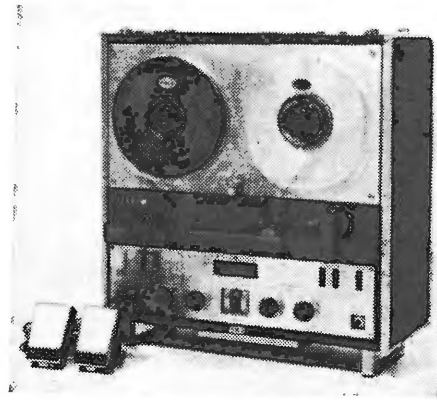
Tannoy "Lancaster" corner loudspeaker unit.



Sony TC 600 four-track tape recorder.

SHURE

An addition to the Dynetic range of stereo cartridges will be the M44-C, intended for use with record reproducers requiring a tracking pressure of 3-5gm, and the M55-E, with elliptical stylus for use with transcription unit arms tracking at $\frac{3}{4}$-$1\frac{1}{2}$gm. All types in the range are compatible, allowing stereo and mono records to be played through stereo or mono equipment. Microphones not previously shown include the 550S omnidirectional dynamic type.

Shure Electronics Ltd., 84 Blackfriars Road, London, S.E.1.

SONOTONE

Two stereo pickup cartridges are to be shown. The Type 9TA has a sensitivity of 80-120 mV/cm/sec at 1,000 c/s and a compliance of 5.3×10^{-6} cm/dyne. Tracking weight is 2-4 gm, and response is within 3 dB from 30 to 15,000 c/s. The other ceramic cartridge, the 9TAHC, has a similar specification and both have average channel isolation figures of better than 20 dB. An electrical load of 2 MΩ and 100 pF is quoted for both cartridges.

Agents: Metro-Sound Manufacturing Company, Bridge Works, Wallace Road, Canonbury, London N.1.

SONY

Four tape recorders along with a precision stereo tape transport and a complete stereo record pre-amplifier are to be shown. The tape recorders are multi-track machines suitable for mono and stereo applications, with the exception of the TC 777A, which is a professional twin-track recorder. The record pre-amplifier has been designed primarily to be used with the new tape transport.

Agents: Debenhams Electrical & Radio Distribution Company, Eastbrook Road, Eastern Avenue, Gloucester.

TANDBERG

Two cabinet loudspeakers will be shown for the first time, the Model 8 and the Model Hi-Fi. They have an impedance of 4 ohms and are suitable for use with the company's transistorized amplifiers, tape recorders and Huldra receivers. The Huldra receivers provide f.m. and a.m. reception and include stereo amplifiers and loudspeakers for record reproduction. Mono tape recorders Series 8 and Series 9 will be introduced, in two-track and four-track versions.

Agents: Elstone Electronics Ltd., Edward Street, Templar Street, Leeds.

TANNOY

The new range of Lancaster loudspeaker units will be shown in addition to the complete range of high-fidelity equipment. The corner Lancaster enclosure (illustrated) is available as a reflex unit with a 12 in loudspeaker and as an aperiodic unit with a 15 in loudspeaker.

Tannoy Products Ltd., Norwood Road, London S.E.27.

TELEFUNKEN

Two a.m./f.m. tuner-amplifiers are featured this year. Both of these cover four wavebands and are fitted with multiplex decoders. Other exhibits are to include two four-speed transcription units, a 30+30 watt amplifier and speaker units.

Agents: Welmec Corporation Ltd., 27 Chancery Lane, London, W.C.

THORENS

A selection of transcription units, including one combined with an automatic record changer, are to be shown. This novel unit, designated TD 224, does not carry a stack of records on the central spidle of the turnable, but selects records (up to eight) from a separate stack at the side of the turntable. When the record on the turntable is finished, it is automatically returned to the bottom of the stack and another from the top is selected and placed on the turntable.

Agents: Metro-Sound (Sales) Ltd., Bridge Works, Wallace Road, Canonbury, London, N.1.

TRIO

F.M. tuners, stereo amplifiers and combined tuner-amplifiers with this Japanese trade name are to be shown. A stereo multiplex adaptor which is suitable for all Trio tuners and can be used on many other makes of tuner is also to be featured.

Agents: Winter Trading Ltd., 95-99 Ladbroke Grove, London, W.11.

TRUVOX

Amongst equipment that will be demonstrated is a new stereo system, the details of which had not been announced at the time of going to press.

Truvox Ltd., Neasden Lane, London, N.W.10.

VORTEXION

The C.B.L. professional tape recorder aims to provide a versatile twin-channel equipment for mono work as well as stereo recording and playback. Mixing is provided on both channels for microphone and gram/radio inputs. Cross-channel mixing allows special effects in monophonic work, such as a singer or musician accompanying himself. Echoes may be introduced and a monitoring facility allows comparison of the original and recorded sounds.

Vortexion Ltd., 257-263 The Broadway, Wimbledon, London, S.W.19.

WHARFEDALE

Two new products which will be on show are the Dalesman and Dovedale enclosures, both with 5in and 12in loudspeakers. The Dalesman can handle 10 watts r.m.s., has an impedance of 10-12 ohms and the 12in loudspeaker uses a ceramic magnet. The larger and wider range Dovedale enclosure houses a bass loudspeaker with an open-baffle resonance of 15-18 c/s, and a Neoprene suspension. The 5in high-frequency unit uses a ceramic magnet with cloth suspension. The impedance of the Dovedale is 12-15 ohms; it can handle 15 watts r.m.s. and incorporates a treble volume control.

Wharfedale Wireless Works Ltd., Idle, Bradford, Yorks.

WHITELEY

Loudspeakers, f.m. tuners, amplifiers and ready-to-assemble bass reflex cabinets are to be shown by the Whiteley Electrical Radio Company. The speakers vary in diameter from $1\frac{3}{4}$ in to 18 in and are available with several different cone constructions, speech coil impedances and magnetic flux densities.

Whiteley Electrical Radio Company, Radio Works, Mansfield, Notts.

WILLIMAN

Overseas visitors will have the opportunity of seeing a selection of British audio equipment available to them through K. H. Williman & Co. This includes products from Armstrong, Kelly, Planet and Rogers, for whom Willimans are exclusive exporters.

K. H. Williman & Company, Blackford House, Sutton, Surrey.

WILMEX

As an export house, Wilmex will be showing several makes of audio equipment, placing emphasis on Ferrograph.

Wilmex Ltd., 151 Clapham High Street, London S.W.4.

WILSON STEREO LIBRARY

The latest edition of the Stereo Index will be exhibited. The book includes reviews of classical and popular stereo records by well-known critics.

The Wilson Stereo Library Ltd., 463 Streatham High Road, London, S.W.16

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LETTERS TO THE EDITOR

The Editor does not necessarily endorse opinions expressed by his correspondent

The Colour Situation

MAY I correct two wrong impressions which may be given by the article on pages 30, 31, of your March issue.

In the BREMA Home Viewing Trials no overall assessment was made of compatibility, but, as the heading to the overall histogram in our report shows, a question was asked on the "Impairment of the monochrome picture (on a colour receiver) due to a colour cast." The sole purpose of this was to assess the effect that any convergence or misregistration errors in the shadow-mask tubes would have on the quality of the colour picture, and no conclusions on dot patterns can be drawn from the results.

These trials were conducted solely to assess whether the average non-technical viewer was capable of adjusting N.T.S.C. receivers so as to obtain good quality pictures, and any other results were incidental. The fact that this was the only supporting evidence given with our statement in favour of the N.T.S.C. system does not mean that supporting evidence for the other claims is not available, but that this aspect was thought to be of such importance as to warrant a special investigation, with a summary of the results being included as an appendix to our statement.

London, W.C.1. D. P. DOO,
Technical Secretary,
British Radio Equipment Manuf. Assoc.

"Applications of Metal Oxide Silicon Transistors"

MR. F. Butler, in his article in the February issue has provided an introductory survey of possible uses of field effect transistors. I would like to point out what I regard as some significant omissions and to comment on one or two of his statements which seem to me to be misleading.

He writes, "In view of the very high input impedance, the amplifier noise figure is exceptionally low, . . .". In fact, the noise behaviour of the device is related only indirectly to the input impedance. A number of theories of the origin of noise prevail, including the effect of high electric fields in the pinch-off region, channel noise, leakage noise, etc. It is beyond the scope of this letter to discuss the pertinent device physics. I think that Mr. Butler means, "Even when coupled to sources having an internal impedance of several megohms, the noise figure is exceptionally low, . . .".

In my evaluation of some ten dozen f.e.ts of United States manufacture while I was actively engaged at de Havilland Aircraft of Canada, I found that m.o.s. f.e.ts exhibited noise performance in the audio range much inferior to p-channel planar diffused silicon junction f.e.ts. However, at radio frequencies, the reverse is said to be true.

This leads to another point of contention. The m.o.s. f.e.t. really comes into its own in high-frequency (r.f.) applications. A good m.o.s.t. should have a noise figure under 3dB at 100 Mc/s and a neutralized power gain of, say, 10dB. The applications illustrated by Mr. Butler can be carried out by junction f.e.ts and do not require a wait for the availability of m.o.s. devices. An excellent summary of the unique features of m.o.s. devices and their relation to junction f.e.ts is contained in a recent feature series[1].

Does Mr. Butler seriously advocate using bias resistors as high as 50 megohms. Leakage currents, sufficient to bias a device into cut-off (or hard on) can arise so unexpectedly, as when a "good" blocking capacitor at the input of an amplifier passes a few nanoamperes of current from, say, an infra-red detector biased at 100 volts when the entire assembly is subjected to a 125°C ambient environment. Further, to maintain good noise performance, carbon resistors cannot be used (even though ideal performance should be achieved as the current to cause current-noise is infinitesimal); wirewound resistors are bulky, costly and pick up noise through their inductive properties; metal film resistors would have to be used in large quantity.

Mr. Butler advocates bootstrapping. Experience shows that the transconductance of f.e.ts is not high enough for this method to provide much increase in the input impedance. At the moment, one of the facts of life is that the purchase price of these devices soars with the gain. Then, too, the valve boys will dig out their mildewed texts and show us that the drain resistive load (plate load) reduces the effective μ available for bootstrapping.

The answer to the dilemma of attaining a high input impedance with components of a reasonable size and securing low noise performance is provided in exploiting positive and negative feedback together in just the manner that Mr. Butler described for bipolar transistors in *Wireless World*[2], and others have described elsewhere. In a recent paper[3] I described the advantages of a hybrid design in which input impedance multiplication is achieved by greater-than-unity-gain drive for the bootstrap connection. The two-transistor amplifier there cited has an input impedance at the input end of a length of shielded cable of hundreds of megohms in parallel with 6pF of capacitance and an output impedance of less than three-hundred ohms at a stabilized voltage gain of ten. It maintains its performance over a wide temperature range and is independent of device differences.

London, S.W.7. IAN H. ROWE,
Imperial College of Science & Technology.

(1) *Electronics*, Vol. 37, No. 30, November 30th, 1964.

(2) F. Butler. "Analysis of the Bootstrap Follower," *Wireless World*, January, 1963.

(3) I. H. Rowe. "Design of Low Noise, High Impedance Amplifiers Using F.E.Ts," *Electronics and Communications* (Canada), March, 1963.

The author replies:—

Since I wrote this paper a number of articles on the basic physics of field effect transistors have appeared and there have also been one or two accounts of practical applications, including a bulletin by Mullard which contains useful information. One cannot track down and read everything and I fear that I missed seeing Mr. Rowe's own contribution. American literature deals mainly with junction-type f.e.ts. as distinct from the insulated-gate type. Both devices are equally suitable for many applications and I chose to discuss the Mullard transistor because of its novelty and topical interest.

Many American papers deal with choppers, low-noise amplifiers and voltage-controlled resistances. Application notes of U.S. manufacturers (Crystalonics, Fairchild and Texas Instruments), tend to cover the same ground, whereas my chief concern was with a broader field of more general interest.

As regards noise figures, I accept Mr. Rowe's correction to my sentence beginning "In view of the very high input impedance, the amplifier noise figure is very low . . " His version is more nearly what I meant to convey, as should be apparent from the context.

I should also like to comment on the spectral distribution of noise power in f.e.ts. I said that the $1/f$ component seems to be absent or abnormally low but now doubt very much if this is true. Everybody seems to agree that the spectrum of f.e.t. noise is not the same as normal transistor noise but much more work is required by physicists and device manufacturers before the facts are fully known. I suspect that some of the noise is inherent in f.e.ts and some

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is capable of reduction by improved manufacturing techniques.

Mr. Rowe's remarks on f.e.t. noise figures at high frequencies are irrelevant to the subject of my paper. Since he has raised the point it should be said that a low noise figure is only one of many design requirements for a tuned r.f. amplifier. Others, perhaps of greater consequence, are linearity (absence of intermodulation), ease of applying a.g.c. and the possibility of wideband neutralization or unilaterization.

I am taken to task for suggesting the use of a 50 megohm bias resistor. Mr. Rowe will therefore be horrified to see the elegant and original electrometer circuit described by Mr. C. J. Mills in the letters on p. 141 of the March issue of *Wireless World*. In this a resistance of 100 kilomegohms is shown, though naturally one would not put a 100-volt d.c. supply in series with it through a blocking capacitor. For normal supply voltages, many modern plastic-foil capacitors have sufficiently good insulation for use in this type of circuit. There is another point. My circuits, and that of Mr. Mills, provide automatic source bias which will do something to offset the effects of capacitor leakage. Furthermore, there is a simple trick for eliminating or greatly reducing the effect. Connect two input capacitors in series and from the junction point connect another high resistance to ground. At d.c. the double CR network gives a potential-dividing effect, causing resistive attenuation of the leakage current.

Mr. Rowe has a point concerning the noise power in carbon resistors, or any other resistors for that matter but he cannot expect me to fight the laws of nature. The r.m.s. noise voltage across a 100 megohm resistor at 17°C in a bandwidth of 100 kc/s is around 400 microvolts. For a carbon resistor carrying d.c. the figure is much worse. The situation is inescapable and the f.e.t. is not to blame.

Because I gave the circuit diagram of a bootstrap amplifier it does not follow that I endorse or advocate the general use of this arrangement. In the past, Mr. G. W. Short and I have pointed out some of the disadvantages of this connection. Moreover I am well aware of the effect of the device transconductance on the performance. Almost the sole merit of the circuit is that its input impedance can exceed the physical resistances of the bias network.

The point about the use of combined positive and negative feedback to give a high input impedance has no relevance to the subject of my article, but while I am writing I would like to correct an error in Fig. 9 of my paper. The high tension line should be marked positive, not negative as shown. Next, I learn from Mullard Ltd. that the substrate lead, left floating in all my circuits, should preferably be connected to the source terminal. If desired, this lead may be used for a.g.c. purposes or for oscillator injection if the transistor is used as a mixer. Another point to note is that in later samples of the 95 BFY device, two electrode leads have been transposed. The base connections shown in my Fig. 1 apply only to early samples. There is also a mistake in Fig. 5. The middle resistance of the three at the bottom of the diagram should be 560 ohms, not 560 kΩ.

To conclude I would like to make a further comment on the electrometer amplifier described by Mr. Mills and on the interesting hybrid circuit noted by Mr. Short. One of the drawbacks of the f.e.t. is Miller feedback through the gate-to-drain capacitance. It is neatly avoided by using the source-follower connection. However, if the source load is capacitive there is some risk of instability as there can be with the ordinary cathode follower, though this cannot happen in the circuit described by Mr. Mills which, incidenally, has almost ten times the bandwidth of more conventional arrangements. The high input impedance makes possible a convincing demonstration of the piezoelectric effect in quartz merely by sandwiching a plate or bar between foil electrodes, adding two insulating outside sheets and compressing the assembly with a pair of pliers. Gentle pressure with a measuring micrometer is enough to show a perceptible reading on an output voltmeter. Screening is required to prevent hum pick-up.

Mr. Short's circuit* is new to me though I believe a similar arrangement was described in the Hewlett Packard Journal for April, 1961. It seems ideally suited for use with f.e.ts and could probably be used as a relaxation oscillator as well as the controlled negative resistance or sinusoidal oscillator which he suggests.

F. BUTLER

[* In G. W. Short's letter (March, p.141, the expression $-\alpha/g_m$ should be $-1/\alpha\, g_m$—Ed.]

Units

MR. D. F. Gibbs' letter (p. 85 February issue) illustrates, I believe, more a continuing defect in mathematical pedagogy than any crankiness in Mr. Gibbs. "Cathode Ray" is fully justified in his strictures on the matter of Mr. Gibbs' letter, yet the fault may properly lie with the latter's teachers. It is, and has been for many decades, fashionable (and ego-flattering) to claim that mathematics, which ought properly to be called arithmetic is *the* school subject that demands thought. That claim has no foundation.

Until computers became common no self-evident rebuttal of the claim was available. Computers do not think, they *do!* The fact that they do faster than man-moved pencils is irrelevant. The man behind the pencil need think no more than the computer, he need only remember and do.

"Thinking" leads to the class of error demonstrated by Mr. Gibbs, viz., the overlooking of the principle that each arithmetical discipline becomes meaningless when any "foreign" axiom is allowed to creep in. There is no single, complete and exclusive set of axioms to link the c.g.s. electrostatic and electromagnetic systems. The systems touch, but do not coincide. Each is true *within the boundaries set by its own axioms* and, in practice, a change of scale at the proper place permits transfer from one system to the other and from both to the m.k.s. systems.

"Cathode Ray" has explained at length in several of his articles that these scale changes are numerical and dimensional, and that the axioms of the m.k.s. systems are preferable to those of the c.g.s. system. It is an interesting (although potentially mischievous) thought that the preference might have been made explicit by calling the new systems c.g.s. (Giorgi).

To make explicit the implications of the above, may it be suggested that our educationists strive towards improving our memories without ruining our ability to think. Thought can be a time-wasting substitute for memory, and is wastefully productive without accurate memory of a fair "quantity" of information.

Glasgow. W. GRANT

THE m.k.s.A system may well be the most suitable for present engineering purposes, and knowing how easily strong feelings are aroused, I was careful to make no direct criticism of it in my letter published in your February issue. "Cathode Ray," as I had feared, sees the matter as a battle between the reactionaries and the progressives. It was rather tempted on reading his reply to pick up the gauntlet and act out the villainous but not altogether unsympathetic part thrust upon me, no doubt disappearing down the trap in the final scene, to the accompaniment of red fire and hisses, my end delayed but not prevented. But I would prefer to stick to my original purpose, which was to emphasize the arbitrary nature of units and dimensions, and to refute suggestions that the c.g.s systems are unsound.

There is little disagreement on the main observations in experiments in classical electricity and magnetism. Having discovered certain proportionalities, we refer some of the quantities measured to existing standards, such as the metre, and define certain new quantities, such as electric charge. When we have a system which we find consistent and convenient, we all too easily assume that all other systems must contain some essential flaw. We are liable to feel that there "must" be some "true" dimensions for every physical quantity. I believe on the contrary that our systems are largely man-made, like a monetary system, or about as arbitrary as our habit of doing arithmetic in the decimal system. It is, of course, possible to devise systems which are self-contradictory, but between the many which are not, we can hardly choose with any degree of objectivity. In classical mechanics, for example, the conventional choice of mass length and time

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as "fundamental" dimensions is not a necessity, one may perfectly well regard force as fundamental and mass as derived.

Perhaps "Cathode Ray's" insistence that volume must be of dimension L^3 demonstrates his own unwillingness to consider an unfamiliar system. I might measure volumes with reference to a standard pot, and decide that volume is an independent dimensional quantity, related to my standard of length by having dimensions kL^3, where k is a dimensional constant. The unit of volume in this system would resemble the ampere in the m.k.s.A system.

The misunderstanding about the dimensions of ϵ and μ is probably mainly verbal. In the context in which they were defined, I would indeed deny that "ϵ and μ possess (separately) certain dimensions." By this denial I mean that they are (separately) dimensionally indeterminate, not that they are both pure numbers. The indeterminacy results from our introduction of two constants instead of one, and the further arbitrary assignment of a magnitude and dimension to one of them results in one of the many systems which seem to cause us so much worry.

The analogy between the mass and volume of a quantity of sugar and the electrostatic and electromagnetic measures of an electric charge still seems to me a fair one. We perform different operations in each case, and our resultant measures differ in magnitude and dimensions unless we insert dimensional constants in our definitions. I cannot see why it should be loose and unscientific to speak of a quantity of sugar if it is not equally so to speak of a quantity of electric charge. Why should electric charge be the same thing no matter how it is measured, while sugar is not? I would say they both remain the same no matter how measured, but methods of measurement may differ.

I cannot, alas, claim any originality in expressing electrical quantities in terms of mechanical ones, for that we must thank such giants as Gauss and Weber. I do not know why "Cathode Ray" says this is in contradiction to Maxwell. In his "Treatise on Electricity and Magnetism," Part IV, Chapter X, the first sentence is "Every electromagnetic quantity may be defined with reference to the fundamental units of Length, Mass and Time." Some users of m.k.s. systems say explicitly that they regard the introduction of a fourth dimensional quantity as a matter of convention and convenience, but some, like "Cathode Ray" and your correspondent Mr. Frank Smith, seem to think it a matter of necessity, often giving as their reasons the avoidance of fractional indices, and of the appearance of different dimensions for different measures which they feel should be the same. The different dimensions may be reconciled, if desired, by the use of dimensional constants in the definitions. I do not understand why fractional indices are considered objectionable. While the matter cannot be settled by appeal to authority, I would sincerely recommend anyone interested in the fundamentals of the subject to read "Dimensional Analysis" by P. W. Bridgman (Yale University Press).

Mr. W. M. Wrigley's letter illustrates the difficulties in discussing this subject. I have carefully searched Condon and Odishaw's "handbook" for the passage which he implies shows that zero dimensions cannot be ascribed to ϵ_0, and I do not even get the impression that this is the author's belief! To be pedantic, I agree with Mr. Wrigley that one cannot ascribe zero dimensions to ϵ_0 "any more than to the velocity of light for instance," but the latter is indeed possible, and is a fairly common practice among certain theoreticians. The resultant equations can be numerically and dimensionally correct. If it is objected that the units used are not practical, that may be true, but it depends on your practice, and in this age of radar and space travel it is not self-evident.

I had read Mr. Bigg's paper, having as a matter of fact been a subscriber to the journal mentioned since its inception, but I take leave to doubt his predictions. As for being "forward-looking"; when I hear that word I reach for my revolving chair. I like to look all round.

Bristol. D. F. GIBBS

"CATHODE Ray" does well to advise us to use the SI system of units. There is little doubt as to the wisdom of his advice, but I wonder if I may comment on the reasons he has given in his article and in the reply (Feb. issue) to Mr. Gibbs? For it is not immediately clear from the article that there are two related issues involved; the need in electricity for 1. an arbitary unit of measurement, and 2. a fourth fundamental magnitude for dimensional analysis.

"Cathode Ray" does not define what he means by "dimensions" (an unusual omission), and perhaps as a result, is less than fair to the gravitational system of units. I take it that the dimensions of a physical quantity show how its numerical value will change when a change is made in the magnitude of the primary units. For the British gravitational system convenient primary magnitudes are those of length (ft), time (sec), and force (lbf). Retaining the pound, mass can be assigned the dimensions $[F\ L^2\ T^4]$. The dimensions of energy are [F L] and so are the dimensions of $\frac{1}{2}m.g.v.^2$. The point is that there need be nothing wrong dimensionally with the gravitational system, even in this curious form; though it is true that people are thoughtless in its use. The reasons against accepting the gravitational system for scientific work are experimental, not dimensional; the standard mass—as a lump of material—is more accurately reproducible than the standard force defined gravitationally. Surely it is for similar experimental reasons that the ampere is chosen as the arbitrary electrical unit.

If, for example, we take as the independent experimental equations the Coulomb laws and the expression for the force on a free pole due to a current element

$$F = \frac{1}{\epsilon_0} \cdot \frac{q_1.q_2}{r^2}$$

$$F = \frac{1}{\mu_0} \cdot \frac{m_1.m_2}{r^2}$$

$$F = \frac{1}{A} \cdot \frac{m.I.\delta s.\sin\theta}{r^2}$$

and for good experimental reasons assume the identity $I = \frac{dq}{dt}$ we have five quantities and three equations. It is not possible to proceed without some assumption. In the SI system, A is taken to be unity leaving μ_0 to be defined. By setting $\mu_0 = 4\pi \times 10^{-7}$ (and thereby defining the magnitude of the force in the definition of the ampere) the SI system obtains as its "absolute" units those found to be of a convenient size for "practical" use. Is it not this simplification which is the great virtue of SI units in electricity?

In dimensional analysis, however, the choice of fundamental magnitudes is—in theory—arbitary, ranging from one to the total number of quantities used. In any problem the number of fundamental magnitudes are chosen to extract the maximum information by dimensional means. Maxwell seems to have believed that all phenomena were ultimately reducible to mechanical terms and so derived dimensional equations for electrical units in terms of the fundamental magnitudes of mass, length, and time. This leads to inconsistency between the e.s. and e.m. system of units, but this reflects only the different way in which the quantities are defined. An alternative treatment to Maxwell's was given by Rucker in 1889 and from this basis generally used dimensional analyses in terms of mass (or energy), length, time, and electric charge, have developed. There are other alternatives for the fundamental magnitudes: mass, length, time, and resistance; length, time, current, and resistance; length, time, charge, and magnetic flux—all have been used for particular problems. The important thing is that these methods use a primary magnitude other than M, L, and T. Dimensional analysis—in practice—has regard for the "physics of the situation". Perhaps in this light Mr. Gibbs is seen to be defending a theoretical position while "Cathode Ray" maintains an experimental one. Certainly even given the generally felt need for an independent electrical unit, we do not necessarily have to use the unit which is defined practically as the fourth fundamental magnitude for dimensional analysis.

All of this may be dismissed as academic nicety, but from the point of view of the teacher it represents a serious practical problem. Efforts to introduce m.k.s. units in schools are often associated with independent ideas for reform in the theoretical structure of electricity courses. It seems to me that this is a

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tactical mistake. The SI system represents a convenient and internationally acceptable method of simplifying units in physics and engineering—for this reason alone, there is every advantage in adopting it. Whether or not we decide to retain magnetic poles in teaching is, by comparison, of minor importance. Unfortunately, theoretical problems similar to those above seem to have obscured what is fundamentally a simple issue.

"Cathode Ray" complains also of mental inertia in other fields. I sympathize. I listen hopefully to B.B.C. weather forecasts; someday they may change to degrees Celsius instead of degrees Centigrade. Of course it is early yet, the recommendation was only made in 1948.

Uppingham. D. G. F. EASTWOOD

The author replies:—

If I believed that there could be only one right system of units I would not have said in my article that two possibilities exist for a coherent f.p.s. system and then gone on to point out that mass and force are alternative fundamental quantities —as Mr. Gibbs now also does. That is not in dispute. What Mr. Gibbs has to do, but so far has not even attempted, is to show why the c.g.s. systems should be retained, when:

(1) Abandoning them in favour of the m.k.s.A. system reduces the number of systems from three to one.

(2) C.g.s. electrical units differ from those in common use.

(3) Their magnitudes are in some cases quite unrelated to practical or even scientific purposes; e.g., the farad is admittedly rather too large, but the e.m.u. unit of capacitance is one-thousand-million times larger still.

(4) The c.g.s. systems conceal the fundamental difference between H and B, to the confusion of students and sometimes their elders.

(5) In dimensional formulæ they involve fractional indices, which are repugnant to common sense.

(6) The constant π occurs where it is inappropriate and is missing where it would be appropriate.

Since the m.k.s.A. system is free from all these disadvantages the term "reactionary" that Mr. Gibbs puts into my mouth for those who, like him, spring to the defence of the c.g.s. systems would seem to be not altogether undeserved.

And is their case really strengthened by the arguments used by Mr. Gibbs? I said that any method of measuring volume that gave it dimensions other than L^3 would have to be looked at rather carefully. Does Mr. Gibbs deny that? If he chooses to introduce a dimensional constant k let him, but I think he would have some difficulty in justifying it, let alone persuading others to follow his example. There is no difficulty on either count as regards the ampere.

Then how does he define "quantity" of sugar? If he defines it so as to make it dimensionally the same as mass, then unit "quantity" would always comprise the same number of molecules. If he defined it in terms of volume, it would not. A "quantity" of electric charge always gives consistent results in terms of, say, electrons. If we found that equal surpluses of electrons appeared to provide unequal charges, some investigation would seem to be desirable. Certainly the mass-defined "quantity" of sugar could be measured by measuring the volume, but density has to be brought in, which converts the result to mass, so there is no dimensional difference between the two measures.

In Art 2, of Maxwell's "Treatise" he says "The dimensions of each term of . . . an equation, with respect to each of the fundamental units, must be the same. If not, the equation is absurd, and contains some error." And in Art. 623, after giving equations connecting the various electric and magnetic quantities, he says, "In order to deduce the dimensions of the twelve units involved, we require one additional equation. If, however, we take either e or m as an independent unit, we can deduce the dimensions of the rest in terms of either of these." He, then, required an independent unit as well as length, mass and time.

I now gather that Mr. Gibbs protested against my saying "nobody knows what the dimensions of ϵ and μ are" instead of "nobody can know. . . ." But, of course, if "nobody can know" my statement must be true! If he can give incontrovertible reasons why "nobody *can* know" and my substituting "can know" for "knows" makes him any happier I would willingly do so.

I do not know why Mr Eastwood thinks I was unfair to gravitational systems. I wrote not a word of criticism of them and acknowledged the foot-pound(force)-second as a coherent system. My criticism was directed at the British mixture of two systems, in which the same name is used for the unit of mass and the unit of force.

I am well aware of the fact that other independent units than the ampere could have been chosen as the fourth in SI; in fact, until the CGPM had made up its collective mind, μ_0 and Q were among those being considered.

I had rather Mr Smith (March issue) did not credit me with the sugar analogy; Mr Gibbs must bear that burden alone. And does he (Mr Smith) deny that electric charge is the same kind of thing no matter how it is measured? That was all I said about it in the letter he criticizes.

My surprise that physicists have, contrary to Mr Gibbs' impression, so largely gone over to m.k.s.A. units was due to the general feeling when they were introduced that if we were lucky they might be adopted by all electrical engineers within about a generation, but pure scientists could hardly be expected to make the change. I am glad that this forecast has proved to be too pessimistic. The progressive reduction of the partition between pure and applied scientists may well have contributed to the result. I am obliged to Mr Wrigley (March) for substantiating my statement that the c.g.s. systems are rapidly moving into past history.

"CATHODE RAY"

Darlington-Cascode Trio

I WAS very interested to read F. Butler's article in the March issue on transistor cascade amplifiers and their various forms that "people keep re-inventing."

I was rather surprised to find that one permutation that I have often used myself, and which I feel is a bit "obvious," did not appear.

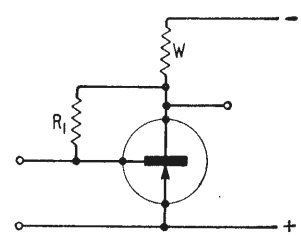

Fig. 1

It derives logically from the feedback stabilized transistor (Fig. 1) which is well known.

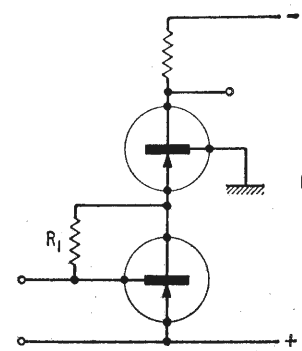

Fig. 2

Substitute a transistor for W and there appears the simple cascode, (Fig. 2) also stable.

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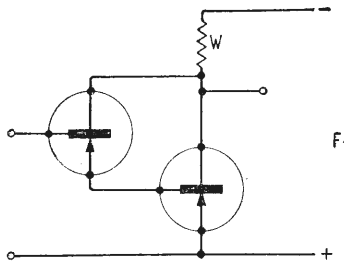

Fig. 3

Substitute a transistor for R_1 instead, and there appears the Darlington Pair in its stable form.

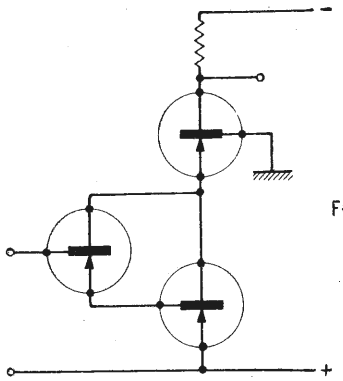

Fig. 4

Substitute *both* and there arrives that chamber-music ensemble, the "Darlington-Cascode Trio"!

Both have a high imput impedance (especially 5(b)) and this is useful for r.f. purposes where the input may well be

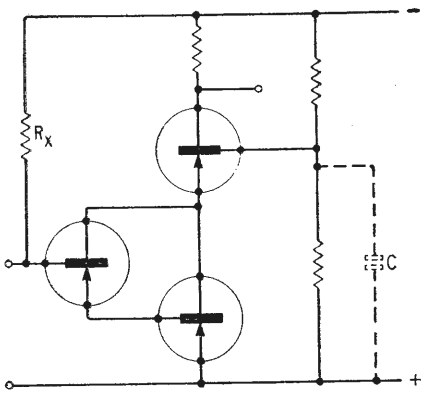

Fig. 5(a)

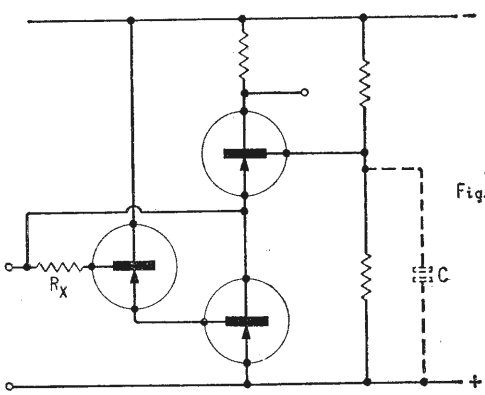

Fig. 5(b)

a tuned circuit that must not be damped too much. Gain is better than with a simple cascode (especially 5(b)) and although I have not had the opportunity of checking its band-width quantitatively, it gives, empirically good results and, minus C, might well give a fairly linear response.

Perhaps Mr. Butler will favour me with one of his scholarly analyses in a future issue of "*W.W.*"

The value of R_X, by the way, needs a rather careful estimate, especially for the 5(b) configuration. In a practical circuit it is high, in the $\frac{1}{2}$MΩ neighbourhood.

Nottingham. D. B. PITT

Transistor High-quality Audio Amplifier

THE surge of joy with which I read, in the article by Mr. Dinsdale (January issue), that the signal-to-noise ratio of a transistor amplifier could be improved by introducing a low resistance from the base of the first transistor to earth, was, I'm afraid, quickly damped. It is not true. It is true that the noise output from a transistor in common-emitter will usually decrease as the resistance from base to earth is decreased; but this resistance will inevitably attenuate the signal to at least the same extent. In the circuit of Mr. Dinsdale's Fig. 6(a), I estimate that the removal of the 1 kΩ resistor (with appropriate adjustment of the frequency compensation) would improve the signal/noise ratio by about 10 dB.

This is not a serious criticism of the design, as the signal-to-noise ratio with the resistor included, assuming maximum output from the crystal pickup, should still be greater than 70 dB.

It is fairly safe to assume, in general, that for the highest signal-to-noise ratio (1) resistances in parallel with the signal path should be as large as possible. (2) resistances in series with the signal path should be as small as possible.

Such resistances would (a) attenuate the signal at least as much as they might reduce the noise output, and (b) introduce their own thermal noise.

Maxims (1), (a) are neatly illustrated by the examples in Mr. Johnson's letter in the same issue, in which the thermal noise of the resistances is evidently neglected. Maxims (1), (2), (b) are illustrated by the fact that with a low-noise valve such as the EF86 the thermal noise of resistors R_1 and R_g, in Mr. Johnson's second example, would form the major part of the noise in the circuit, and the improvement due to changing R_g would be, not 17 dB, but about 10 dB.

The feedback, incidentally, has a negligible effect on the noise performance; the same figures would apply if the 10 MΩ resistor were removed.

Accra. F. HIBBERD

University of Ghana, Department of Physics.

National Certificate Courses

IS it not time for the professional institutes and the Ministry of Education to take a more liberal attitude over the entry standards for the Higher National Certificate?

I speak for the thousands who drift into electronics with "A" level qualifications. Even with three "A" levels we still have to start at the beginning of the O.N.C. if we don't have the correct "O" levels.

In my case I have three "A" levels. I have been working in electronics for seven years and I earn £1,400 a year purely because of my knowledge of electronics. Yet I can't study for an H.N.C. I can get £16 per week grant if I study for an H.N.D., a Dip.Tech. or a degree, but it seems that an H.N.C. is in a more exclusive class.

The really annoying thing is that professional institutes accept the H.N.C. as an exemption for their intermediate examinations. This means technical colleges do not run courses for these intermediate examinations. Just to help things along, the professional institutes won't accept candidates who have not taken these non-existent courses. The last time I pointed this out I was informed that I could take an external degree to exempt me from part 1 of the Grad.Inst.P. examination.

London, N.W.5. I. LESLIE

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ELECTRONIC LABORATORY INSTRUMENT

4.—MEASUREMENT OF ALTERNATING VOLTAGE AND CURRENT

IN any good electronics laboratory nowadays you will find a range of instruments for measuring alternating voltages and currents at frequencies from 10 c/s to 1,000 Mc/s. Such instruments, on whatever principle they work, pose two main problems for the user: how to check calibration easily, and how to avoid "waveform errors."

Calibration checking, as we saw in an earlier article, is not too difficult with d.c. measurements because d.c. standards of voltage and resistance (and hence current) are not too hard to come by. But no a.c. primary reference standards exist, and a.c. meters have to be calibrated from a d.c. standard by means of some "transfer instrument." Such an instrument responds equally to a.c. and d.c., so that readings for a.c. can be taken and compared with readings from a d.c. standard.

The other practical difficulty with a.c. measuring instruments is that readings can vary with the waveform of the applied signal. Depending on its principle of operation, an a.c. meter may have a response (i.e., give a reading) proportional to the average, the effective (i.e., r.m.s.) or the peak value of a signal. Most a.c. meters, however, are scaled to read the r.m.s. voltage of an assumed sinewave signal, irrespective of their real response law. "True r.m.s. reading" instruments (i.e., with an r.m.s. response law), should show a correct reading, whatever the waveshape. On the other hand, average-reading or peak-reading instruments, when scaled to read r.m.s., may display large errors if the waveform departs materially from a sinewave. In general, average-reading meters are likely to give more accurate "r.m.s." readings than peak-reading ones. It can be shown in theory that for average-reading meters the error may vary from −100% to +11%, and for peak-reading meters from −100% to + 0%.

There you have, then, the two main practical difficulties that beset the measurement of alternating current or voltage—the difficulty of calibrating, and the difficulty of measuring non-sinusoidal waveforms. Keeping these in mind, you are now faced with the problem of "what to use to measure what?"

A.C. Meter Types

Some a.c. meters primarily measure voltage, and others current. The distinction is not important, however, because you can always use a current meter to measure voltage by measuring the current through a series resistor, or a voltage meter to measure current by measuring the voltage drop across a shunt resistor.

Over the years, many different types of instruments have been used to make measurements of alternating voltage or current. Those which you may possibly come across in an electronics laboratory are:

(1) Dynamometer, (2) moving-iron meter, (3) rectifier meter, (4) thermocouple meter, (5) valve voltmeter, (6) digital voltmeter, (7) electrostatic meter, (8) oscilloscope, (9) a.c. potentiometer, and (10) heterodyne-mixer meter.

Of these ten types, you will find three used in almost every laboratory: (3) rectifier meter, (5) valve voltmeter, and (8) oscilloscope. It is, however, useful to know something of the other types, particularly where the all-important problem of calibration arises. We will therefore take a look at all of them before we go on to the practical aspects of "ordinary" a.c. measurements.

Dynamometers

The dynamometer (also known as the "electrodynamometer") is the basic instrument for a.c. measurements, just as the permanent-magnet moving-coil meter is the basic instrument for d.c. measurements. The dynamometer comprises a movable coil, with a pointer attached, suspended in the field of another fixed coil. The current to be measured passes through both coils in series and the deflection of the pointer indicates the value of current measured. The instrument responds to d.c. as well as a.c. and is therefore a basic transfer instrument for calibrating. It has an r.m.s response, and the a.c. reading for any deflection can be checked by applying known d.c. to give the same deflection.

The main limitations of the dynamometer are:

(1) Not having a strong fixed permanent magnet, it is much less sensitive than the moving-coil meter, and its lower current limit tends to be in the mA rather than the μA region.

(2) While accuracies as high as 0.1% can be achieved with a precision dynamometer at frequencies up to a few hundred cycles per second, it is normally not of much use above 1,000 c/s since its accuracy falls off rapidly with rising frequency. (A special form of r.f. dynamometer has been developed for use into the r.f. range but

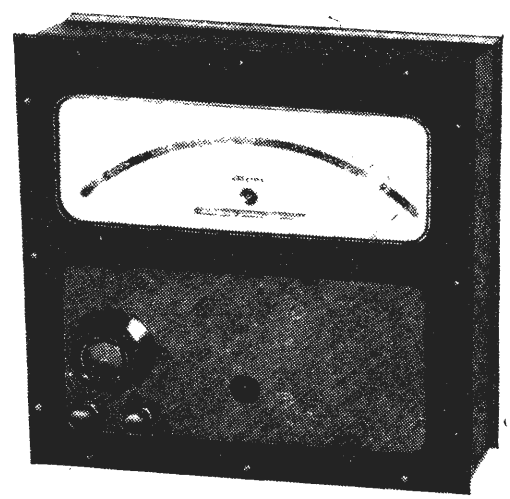

Fig. 21. Typical commercial example of a.c./d.c. dynamometer: Sangamo Weston S93 dynamometer-type ammeter.

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PRACTICE

By T. D. TOWERS,* M.B.E., A.M.I.E.E., A.M.I.E.R.E.

it is not likely that you will come across this in the ordinary laboratory.)

Dynamometers you will meet are likely to come from one of the following firms: Cambridge Instruments, Elliott's, Pullin, Salford and Sangamo Weston. Fig. 21 shows a typical good example, the Sangamo Weston, S93 dynamometer type ammeter. With a guaranteed accuracy of 0.1 f.s.d. from 25 to 2,500 c/s and a maximum sensitivity of 1A f.s.d., this instrument has a 12-in scale, is magnetically shielded, has a self-contained thermometer, and is provided with a spirit-level and levelling feet.

Moving-iron Meters

Another class of instrument widely used for a.c. measurements is the moving-iron meter (also called iron-vane meter). This comprises a single fixed coil and a soft-iron movable vane with a pointer attached to it. When current is passed through the coil, it deflects the iron vane and thus the pointer.

This meter responds to both d.c. and a.c. Its response to a.c. is r.m.s. Without a permanent magnet, sensitivity again tends to be low compared with a moving-coil meter —only about 10 mA at best.

As the moving system carries no current, the moving-iron meter can be used for measuring higher currents than the dynamometer. Also since the moving parts can be designed without considerations of current carrying, the meter can be more ruggedly constructed and is not so easily liable to damage by overload. Finally, because a wide range of instruments can be constructed with the same moving system merely by changing the coil, the moving-iron meter tends to be relatively inexpensive. In summary, moving-iron meters are cheaper, sturdier and less accurate than electrodynamic meters.

Eddy currents and coil inductances can cause frequency and waveform errors in moving-iron instruments. Ordinary voltmeters and ammeters of this type are calibrated at a single frequency, usually between 25 and 125 c/s. Compensated instruments are available also for use up to 2,500 c/s, but it is at mains frequency that the moving-iron meter is most commonly used.

The accuracy of a moving-iron instrument can vary from several per cent on robust portable units down to 0·5% on the best lab. standards.

Among the companies marketing moving-iron meters are Pullin, Salford, Sangamo Weston, Taylor, Turner and Weir. No illustration of a moving-iron meter is given, because they look externally very similar to the dynamometer types discussed immediately above.

Rectifier Meters

Dynamometers and moving-iron a.c. meters generally are low in sensitivity, they load circuits unduly, and are limited in frequency response to a few hundred cycles per second. Improvement in these respects can be achieved by using the inherently more sensitive moving-coil d.c. meter in conjunction with an a.c. rectifier to produce the a.c. "rectifier moving-coil meter" or simply "rectifier meter."

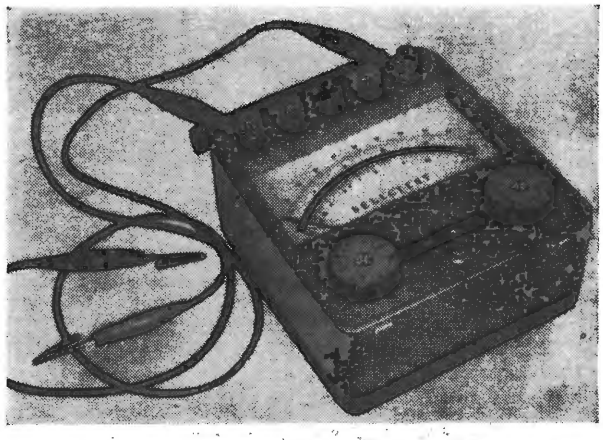

Fig. 22. Typical multimeter exemplifying use of rectifier meter arrangement in a.c. ranges: Salford Selectest 50.

The moving-coil meter indicates the average value of the rectified a.c. signal. Usually, however, the scale is calibrated in terms of r.m.s. for a sinewave. Measurement of non-sinusoidal waveshapes is accompanied by an error varying with the form factor (which was theoretically not present with the dynamometer and moving-iron meters).

Rectifier meters can be basically more sensitive than the others, and can be obtained with current sensitivities as high as 100μA f.s.d. a.c. or with voltage sensitivities as high as 2·5 V f.s.d. a.c.

The input impedance of the rectifier meter is about ten times higher than for dynamometers or moving-iron meters, typically 1,000 ohms per volt, compared with 100 ohms per volt.

The modern rectifier meter is reasonably accurate up to about 10,000 c/s as compared with a limit of 1,000 c/s for the other two types.

The B.S.I. Standard Specification No. 89/1954 for industrial grade portable moving-coil instruments specifies $\pm 2\frac{1}{4}\%$ f.s.d. on a.c. ranges. This is a little over twice as wide a tolerance as the d.c. specification for the same type of instrument. In practice, when an instrument has been in use for a little time, it is prudent not to expect much better than a 5% accuracy on an a.c. rectifier meter.

The main advantages of the rectifier meter are ruggedness, resistance to overloads, long life, small size and no requirement for external power supply. Its main disadvantages are that its accuracy is somewhat low except at normal room temperature and for low-frequency pure sinewaves. You should look on rectifier meters as excellent general-purpose instruments but not ideally suited to precision work.

The a.c. ranges of general-purpose multimeters use the rectifier meter basic arrangement. Rectifier meters are also available separately as single-purpose instruments. In a laboratory you may thus come across rectifier meters in instruments of such firms as Avo, Daystrom, Philips, Pullin, Salford, Sangamo Weston, Smith, Taylor and Turner. Fig. 22 illustrates one example in the well-

* Newmarket Transistors, Ltd.

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Fig. 23. Example of commercial a.c. thermocouple meter: Taylor "Clarity" Model 42.

known Salford Selectest Super 50 multimeter with an a.c. range of voltage down to 2.5 V f.s.d. and current down to 25 mA f.s.d.

Thermocouple Meters

Another class of a.c. instrument which may be met with (although a little uncommon) is the thermocouple meter. In this, the current to be measured is passed through a thermocouple (or through a wire in close proximity to a thermocouple) and the resultant heat produces a thermal e.m.f which is measured. Since it is the heating effect only which is significant, either a.c. or d.c. may be measured.

Such types of meters can cover from d.c. to 100 Mc/s, and find their principal use as transfer instruments from high frequency a.c. to d.c. The usual current ranges are from 3 mA to 300 A f.s.d. Accuracies are of the same order as other a.c. meters, i.e. about 2% for panel instruments, and up to 0.5% for the more expensive portable standard instruments when used in the lower frequency ranges.

A major disadvantage of the thermocouple meter is its susceptibility to overload damage. Permissible overloads range only from 50% to 200% at maximum.

Among the companies supplying thermocouple meters are Pullin, Sangamo Weston and Turner. Fig. 23 shows a typical example in the Taylor Clarity range with a f.s.d. of 100 mA capable of operation with ±2% accuracy.

Valve Voltmeters

Probably the commonest way nowadays to measure an alternating signal voltage or current in the laboratory is to use an a.c. valve voltmeter. Like the rectifier meter, this functions by rectifying the alternating signal and reading the result on a d.c. meter. The main difference is that the valve voltmeter uses amplification either by an a.c. amplifier before rectification or by a d.c. one after rectification.

Valve voltmeters can be used at low frequencies as an alternative to rectifier or other type meters, but they come into their own for higher frequency measurements. Instruments can be obtained to operate up to 1,000 Mc/s.

In the lower frequency ranges, the valve voltmeter has a very high input impedance, normally between 0·5 and 100 MΩ, typically 10-20 MΩ. Input capacitances as low as 1 pF are possible, but 20-30 pF is more usual. Generally the input impedance decreases considerably as the frequency rises.

Valve voltmeters are usually scaled in terms of r.m.s. Since the diode rectifier responds basically to peak voltage, errors can occur when non-sinusoidal waveforms are measured. The errors may be positive or negative and can vary in amount with the phase of the harmonic content of the measured waveshape. There is also a polarity effect in that the positive and negative peaks may not be equal. When very short pulses are measured, a very large error can occur. You should always look carefully at the reading of a valve voltmeter and consider whether the waveshape can have any significant effect on it.

Fig. 24 shows two good examples of commercial a.c. valve voltmeters in common laboratory use. (A) is the Marconi TF 2600 with 1 mV f.s.d. in its most sensitive range and a 5% accuracy bandwidth of 10 c/s - 5 Mc/s. (B) is the Advance VM78, which is transistorised. This, too, has a most sensitive range of 1 mV f.s.d. and a 3% accuracy range of 1 c/s-1Mc/s. Apart from Advance and Marconi, some other names in the a.c. valve volt-

(*Continued on page 201*)

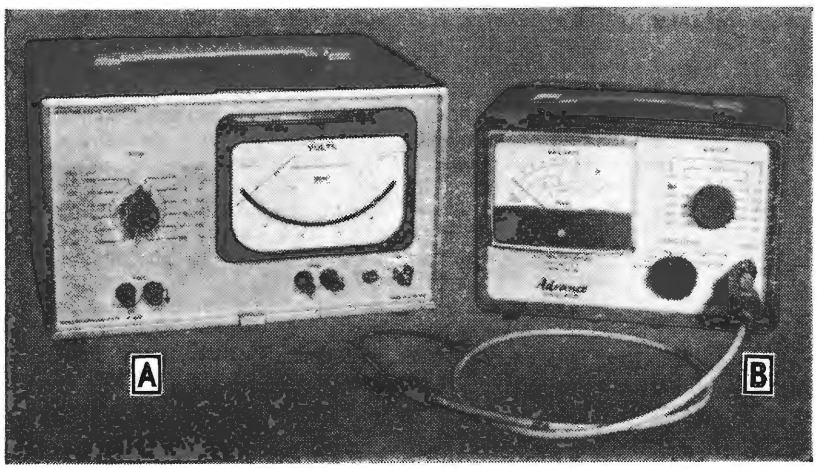

Fig. 24. A.C. valve-voltmeters: (A) Marconi TF2600; (B) Advance VM78 (transistorised).

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meter field are Airmec, Avo, Dawe, Daystrom, Furzehill and KLB (Paco).

A.C. Digital Voltmeters

The digital voltmeter (d.v.m.) is essentially a d.c. measuring instrument. However, by using an a.c.-to-d.c. converter, the d.c. d.v.m. can be turned into an a.c. one.

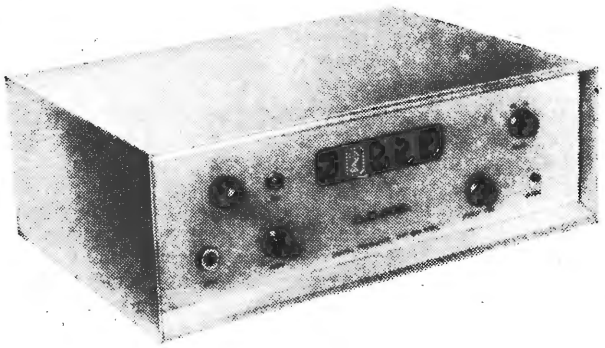

Fig. 25. A.C./D.C. digital valve voltmeter: Applied Developments 1055.

The converter can be a separate unit, or can be incorporated in the main d.v.m. to give the a.c./d.c. type of d.v.m. that is now becoming common. Fig. 25 illustrates a typical example, the Applied Developments Type 1055. Instruments of this type are capable of 0.3% accuracy on a.c., but for this order of accuracy are normally used only in the audio and supersonic frequency ranges. At reduced accuracy, or for accurate differential measurements, it can be used out to the megacycle range however. Other manufacturers supplying a.c. d.v.ms are Digital Measurements, EAL, Gloster, Hewlett-Packard, Roband and Solartron.

Electrostatic Voltmeters

Electrostatic attraction or repulsion forces are used in a type of instrument known as the electrostatic voltmeter. This is capable of measuring voltages, d.c. or a.c., up to megacycles, from millivolts to hundreds of kilovolts. As the d.c. and a.c. responses are alike when the meters are suitably constructed, they may be used as transfer instruments. With proper design they can also be used as primary standards in the measurement of high voltage.

Electrostatic voltmeters have high input resistances, often of the order of 10^{15} ohms. On d.c. there is thus practically no current drawn. However, input capacitance causes a small current drain in a.c. instruments, and this is the limiting factor in the upper frequency range.

The full-scale deflection in commercial units can be as low as 120V or as high as 100kV. One practical point is that the input capacitance tends to increase with deflection and can range from a few picofarads up to several hundred.

A good commercial example of the electrostatic voltmeter, the W. G. Pye Type 11314, is illustrated in Fig. 26. This instrument gives direct readings of up to 40kV, d.c. or r.m.s. a.c., with an absolute accuracy of ±10% full-scale deflection, regardless of waveform. When special mounting precautions are taken the accuracy of comparative readings can be of the order of 0.1% and the d.c./a.c. transfer characteristic even better. It finds particular application in measuring the high voltages encountered in work on cathode-ray tubes.

Oscilloscopes

The oscilloscope can be used for measuring alternating voltage and current. It has the basic advantage that the waveform can be seen and consequently waveform errors estimated.

The usual method of measurement is to apply the voltage to be measured at the Y-amplifier input terminals. Where the oscilloscope has been calibrated at its main sensitivity control, the peak voltage can be read immediately. Oscilloscopes afford the most accurate method of making true pulse peak measurements.

Calibration can be by means of an a.c. signal source of known amplitude operating within the known bandwidth of the signal of the oscilloscope, or by a known d.c. voltage. The more common method is the d.c. approach, where you apply a known d.c. to the Y-amplifier (direct coupled) and note the vertical shift difference necessary to return the trace to its original position. You then apply the a.c. signal to be measured, and measure the peak-to-peak voltage by Y-shift on the calibrated shift control. Cathode-ray tubes can be used as precision transfer instruments.

Instead of calibrating by comparison, a slide-back technique may be applied with a d.c. 'scope. This uses a variable d.c. source in series with the unknown voltage to bring the peak deflection back to the zero point.

A.c. measurements on an oscilloscope can be accurate over the frequency range of the Y-amplifier. The oscilloscope can be used beyond these limits but separate calibrations will have to be made at the frequencies to be measured.

We have been discussing so far the measurement of alternating voltage signals on the oscilloscope, but clearly current may be measured by shunting the oscilloscope input with a known standard resistor.

In standard oscilloscopes, the input impedance is generally greater than 1MΩ, making it possible to measure alternating voltages in circuits of fairly high impedance. The input impedance of the oscilloscope

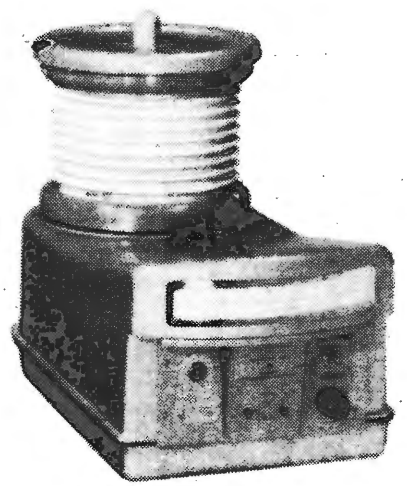

Fig. 26. Commercial electrostatic a.c./d.c. voltmeter: W. G. Pye 11314.

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can be much greater if the signal is applied directly to the deflection plates rather than to the amplifier input.

A.C. Potentiometers

In a.c. work the potentiometer is not as widely used as in d.c. work for the accurate comparative measurement of voltage. This is because in the a.c. case it is necessary to balance phase as well as magnitude, to take stray pick-up and coupling into account, and to consider the effect of harmonics on one or other of the voltages being compared. Also, for a.c. there is no standard voltage source for reference corresponding to the d.c. standard cell. Generally a transfer technique has to be applied to establish an a.c. reference voltage. Despite these difficulties, however, a.c. potentiometers are available commercially. A good example of this is the Cambridge Instruments A.C./D.C. Comparator illustrated in Fig. 27. This is designed to measure r.m.s. value of currents and voltages to an accuracy of $\pm 0.05\%$ over a frequency range of 25c/s to 20kc/s. The instrument contains its

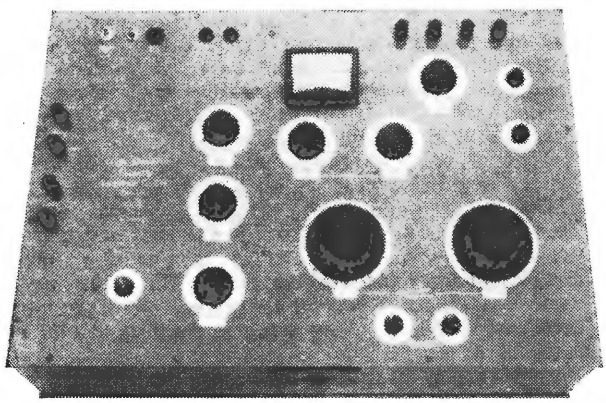

Fig. 27. AC/DC potentiometer: the Cambridge Instruments AC/DC Comparator.

own potentiometer circuit, and the only external units required are a standard cell and a suitable reflecting galvanometer. A meter is incorporated so that the approximate value of the unknown signal can be determined before the setting of the controls. This reduces the probability of overloading the vacuo-junction which is used as an internal a.c./d.c. transfer standard. The comparator has eight voltage and current ranges from 0.5V to 300V full scale and from 5mA to 300A respectively.

Heterodyne-mixer Meter

A linear mixer can be employed to reduce measurements over a range of high frequency to measurements at a single low frequency. A known fraction of the unknown signal is applied to a mixer together with an auxiliary local-oscillator signal of a much greater magnitude. The resulting intermediate frequency passes through a standard attenuator to a meter. A single calibration point is established at each frequency by feeding a known signal into the input. Provided signal linearity is maintained by keeping the unknown signal sufficiently small, the change in attenuation necessary to keep the meter at its reference level is an indication of the desired measurement value. The heterodyne-mixer type of a.c. meter is not commonly used in ordinary laboratories.

Special Problems of V.H.F. and U.H.F. Measurements

In general the measuring instruments described so far have been primarily for frequencies below 150 Mc/s. Above 150 Mc/s difficulties creep in. In the v.h.f./u.h.f. range, voltages and currents often have to be measured in tuned circuits, and it becomes extremely difficult to make measurements without disturbing the circuit unduly. Apart from this, circuit elements can no longer be treated as lumped, so that it becomes difficult to locate two specific circuit points across which a voltage, for example, can be measured. Because of this, you very often find that at v.h.f. and higher frequencies you do not make a voltage or a current measurement so much as a power measurement. The power measurement is usually made by looking at the temperature rise in some indicator due to the dissipation of the r.f. power. This implies the use of some thermal meter such as a thermocouple unit.

The other major difficulty is that at v.h.f. and higher frequencies, the input impedance of the meter becomes complex and varies with frequency; this can lead to calibration difficulties.

Some specially developed versions of the basic instruments referred to earlier for lower frequencies have been developed to operate into the v.h.f. range. In general, however, in the normal laboratory, voltage (and derived current) a.c. measurements above 150 Mc/s or so are normally made with some form of valve voltmeter, at least up to 1,000 Mc/s. Above 1,000 Mc/s the field becomes very specialized and bolometer or other thermal-type meters are normally used.

Practical Points on the Use of A.C. Meters

(1) Always follow the "good-practice" precautions for instruments generally outlined in previous chapters. In a.c. measurements some of the precautions take on a special importance, however. For example, always look extra carefully to the earthing of the equipment under test and the measuring instrument. Earth loops can easily give rise to inaccurate readings, particularly at radio frequencies.

(2) Watch out for mains hum or other spurious frequencies getting on to the signal you are testing. Mains hum is particularly difficult at very low level a.f. measurements, i.e. in the millivolt r.m.s. region.

(3) Always adopt some standard procedure in recording measurements. Do not use r.m.s., average, peak, peak-to-peak interchangeably at random. Over the years I have built up a consistent habit of recording the signals for linear amplifiers in terms of r.m.s. (i.e. in effect assuming a sinusoidal waveshape), and for non-linear circuits (pulse, or large-signal sinewave with some clipping) in terms of peak (i.e. half peak-to-peak) because this can be read off so easily from an oscilloscope.

(4) Always consider the frequency of the a.c. signal you are measuring, and check that it falls within the specified bandwidth capabilities of your measuring instrument. A common failing in this is to try to measure signals at say 10 Mc/s with a valve voltmeter not capable of accurate measurement over say 1 Mc/s. This may seem very elementary, but it is surprising how often you

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find quite competent bench engineers doing this without thinking.

(5) At r.f. always look to see that the circuit disturbance introduced by your measuring instrument is fully taken into account.

(6) Where you are using an instrument, such as an Avo multimeter, with floating input, i.e. with no specified earth terminal, always as a precaution reverse the leads and take a second reading. If this does not agree with the first reading, something is wrong. This is a useful practical step which soon becomes a reflex action with a good engineer. It is just another illustration of always trying to cross-check everything you do.

(7) Where you are trying to measure the voltage or current of an unknown waveshape, try if possible to display it on an oscilloscope at the same time, so that you can interpret the meter reading properly.

(8) Don't rely on the mains voltage to help you with calibrating an a.c. instrument except as a rough check. Nowadays, a nominal mains voltage of 230 V a.c. can lie at any time anywhere between 200 and 250 V. It is not uncommon to find the mains even lower than 200 V on occasion.

(9) Don't forget that a multimeter in its a.c. range has a certain d.c. input resistance. It is not capacitor-isolated and so may affect the d.c. bias conditions of the circuit being tested. This is important in the new-generation direct-coupled audio power amplifiers. Always look to see if you should d.c.-isolate the meter in its a.c. ranges by means of a large coupling capacitor. In other terms, don't forget that if a multimeter in its a.c. range is connected into circuit with a standing d.c. voltage on it, the a.c. meter reading can be inaccurate because of the spurious d.c. imposed.

BOOKS RECEIVED

Transistor Ignition Systems Handbook, by Brice Ward. A short, down-to-earth American text, including a good deal of material on commercial systems already in use in the U.S.A. but with a sufficiently general treatment to interest the British reader (who is warned of possible dangers in a British foreword). Pp. 128. W. Foulsham & Co. Ltd., Yeovil Road, Slough, Bucks. Price £1.

Simplified Modern Filter Design, by Philip R. Geffe. Nearly half of this 182-page book consists of tables and associated diagrams, compiled to enable the circuit engineer to design filters without the use of higher mathematics. In addition to the usual filter configurations, the book describes measurement techniques and the design of practical high-Q inductors. Published in Great Britain by Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price £2 10s.

Wireless for Beginners, 5th edition, is an old book (by C. L. Boltz and first published in 1933) completely revised by Thomas Roddam, who is well known to *Wireless World* readers. The original material on television has been expanded and includes colour television. Transistors, sound reproduction and frequency modulation are dealt with. Pp. 232. George G. Harrap & Co. Ltd., 182 High Holborn, London, W.C.1. Price 18s.

Automatic Voltage Regulators and Stabilizers, 2nd edition, by G. N. Patchett, Ph.D., B.Sc.(Hons. Lond.), M.I.E.E., M.I.R.E., M.Brit.I.R.E. New material on the Zener diode, transistor circuits, tap changers on large power transformers and alternator voltage regulators has been added to the original text, first published in 1954. There are now 80 pages of references, indexed! Pp. 468. Price £3 5s. Sir Isaac Pitman & Sons Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2.

Writing Technical Reports, by Bruce M. Cooper. A Pelican paper-back, drawing on the author's experience of conducting report-writing classes for scientists and engineers. Numerous extracts from typical reports are provided and analysed, and there is a section on illustrating technical writing. Pp. 188. Penguin Books Ltd., Harmondsworth, Middx. Price 3s 6d.

Elementary Particles, by A. A. Sokolov. English translation of a short Russian guide to the more recently identified elementary particles, their prediction and discovery (the positron, nucleons and pions, the neutrino, muons, resonons, etc., together with the various anti-particles). Pp. 75. Pergamon Press Ltd., Headington Hill Hall, Oxford. Price 10s.

Introduction to Semiconductor Devices, by M. J. Morant, B.Sc.(Eng.), Ph.D. Intended to bridge the gap between applications books and books on pure semiconductor physics. This concise work (pp. 126) is about equally divided between the physics of the subject and semiconductor devices considered as active elements of electrical networks. Level: second year of a degree course in electrical engineering. George G. Harrap & Co. Ltd., 182 High Holborn, London, W.C.1. Price 18s.

Gas-Discharge Tubes, by H. L. van der Horst. A comprehensive review of the most important tubes in common use, intended to assist technicians in application problems. Some of the tubes described are now being superseded by semiconductor devices, but others, such as counter and indicator tubes and mercury vapour rectifiers, are still in wide use. Pp. 318. Philips Technical Library. Distributed in U.K. and Eire by Macmillan & Co. Ltd., 10-15 Martin's Street, London, W.C.2. Price £2 17s 6d.

ABC's of Boolean Algebra, by Allan Lytel, explains symbolic logic and how electronic circuits perform logical functions. The translation of algebraic expressions into practical switching circuits is dealt with, and numbering systems are discussed in order to explain how logic circuits can be combined to perform calculations. Pp. 112. W. Foulsham & Co. Ltd., Yeovil Road, Slough, Bucks. Price 16s.

Design of Low-Noise Transistor Input Circuits, by William A. Rheinfelder. The first half of the book discusses the general characteristics of noise, the noise factor concept and measurement of noise figure, while the second half deals with the design of particular classes of circuits: above 100 Mc/s; receiver front ends below 100 Mc/s; and audio circuits. Pp. 160. Published in Great Britain by Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price £1 10s.

Elementary Electrical Network Theory, by D. G. Tucker. Professor Tucker excuses himself for producing yet another book on network theory by pointing out that this is a small one (pp. 169) which aims to provide all the theory required by a student in the first two or three years of a university course or in a course for a professional qualification. An introduction to non-linear circuit theory is included. Price 17s 6d. **Linear Network Theory,** by K. F. Sander is rather more advanced, covering network analysis as taught in the last years of an honours degree course. Again small (pp. 164), it concentrates mainly on the algebra. Price £1 1s. Both from Pergamon Press Ltd., Headington Hill Hall, Oxford.

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Audible Rate-of-Climb Indicator

SIMPLE ELECTRONIC DEVICE FOR GLIDER PILOTS

By J. M. FIRTH

IT has been recognized for some time that it is undesirable that a glider pilot should spend a great deal of his time concentrating on his instruments; he should be looking out for other aircraft. His most important instrument is a sensitive rate-of-climb meter, or variometer, usually electrical, working on a hot bead principle.*

A typical circuit is shown here, Fig. 1. The thermistors Th I and Th 2 are heated by the current in them. Air flowing into or out of a Thermos bottle, due to the pressure change with rise or fall, is directed by small jets over one thermistor or the other, hence giving an up or down reading on the meter.

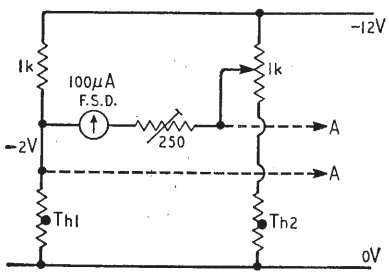

Fig. 1. Basic "variometer" or rate-of-climb meter circuit.

A recent improvement has been the addition of an audio circuit producing a varying tone with pitch propotional to the meter reading, above a certain threshold. The pilot can set the threshold to bring in the audio circuit at any desired rate of climb, thus relieving him of the need to glance at the meter frequently.

There must be many other fields in which this device might be of use, e.g., coupled to an electrical r.p.m. meter, and generally in any situation where an electric meter presents continuous information.

The circuit shown in Fig. 2, for a glider variometer, can be easily modified to accept different input levels. It can be constructed using cheap transistors and no special components.

The first stage is a long-tailed pair, with emitter resistors to raise the input impedance and stabilize the gain. It was designed to be driven fully by the voltage across the meter. Other input circuits are suggested later.

Tr3 and Tr4 are current sources driven by the first stage. They feed current to the bases of Tr5 and Tr6 which form an astable/bistable multivibrator. No output will be produced from this stage until the signal is large enough to turn on Tr3 and Tr4. Tr6 drives the output stage directly.

The threshold is set by RV_1, and RV_2 is a simple volume control which, used in series in this way, gives a saving in current when the volume is turned down. An ordinary cheap headphone can be used as the loudspeaker. This makes quite enough noise in a glider cockpit on a 12 V supply.

In this circuit the oscillation starts at 300-400 c/s and continues up to 8-10 kc/s at the top of the useful range. Tr1, Tr3, Tr5, and Tr6 can all be low-frequency, small-signal germanium types, with the proviso that Tr5 and Tr6 must be able to support a reverse base bias equal to the supply. If Tr6 is chosen to have a higher β than Tr5, Tr6 will normally be bottomed in the quiescent

*See, for example, "The Electric Variometer," by P. G. Davey, Technical Papers of OSTIV (Organisation Scientifique Internationale du Vol à Voile), June 1961.

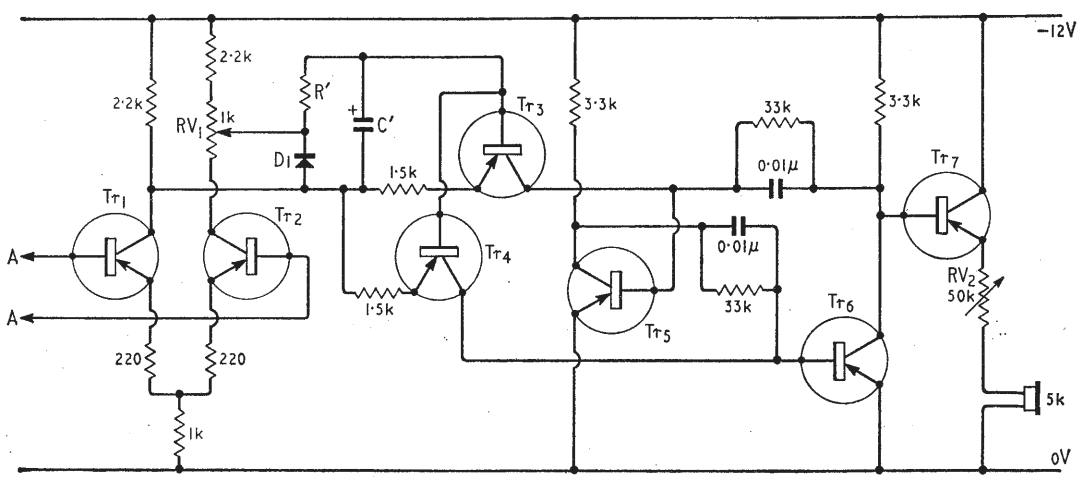

Fig. 2. Transistor tone generator circuit.

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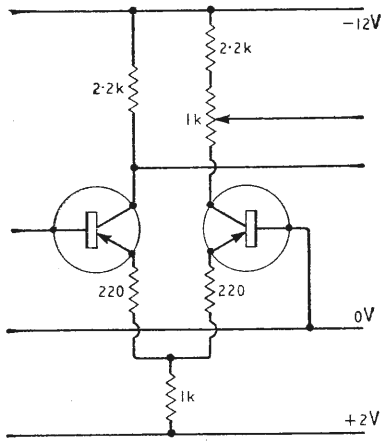

Fig. 3. Modified circuit for inputs varying about, or just above the 0V line.

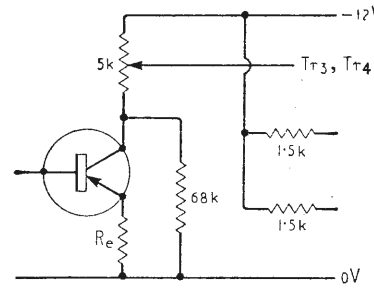

Fig. 4. Alternative circuit for inputs about 1V with respect to earth.

state, and Tr7 will draw no current. Tr3 and Tr4 must be silicon n-p-n types, but can have quite low β's. Tr7 does not dissipate much power, as it is switched hard on and off, but it must have an adequate current gain at full working current. Again, it can be a low-frequency germanium type.

More gain can be obtained from the first stage at the expense of lowering the input impedance, by decreasing the emitter resistors, but care must be taken to leave Tr1 and Tr2 with sufficient working collector voltage.

Fig. 3 shows how the input circuit can be modified to accept an input which varies about, or just above, the 0V rail. Fig. 4 indicates how one might eliminate the +2V rail, but can only be used where the source provides an input of about one volt as the knee voltage of the transistor must first be overcome. The 68kΩ resistor povides a little forward bias for the second stage. With the above disadvantage goes those of poor initial linearity and large temperature drift. However, this circuit may be suitable for use with a car r.p.m. meter, where one side of the meter is probably grounded.

A word of caution here; many frequency indicating devices such as the r.p.m. meter, supply the meter with pulsed current, and the audio circuit may not cope with this, or may produce an objectionably modulated output. The addition of C′ and R′ shown in Fig. 2 will overcome this. With RC=0.1 sec, suggested values are R=10kΩ and C=10μF. D1 prevents the electrolytic capacitor from being reverse biased.

The circuit can be used with other supply voltages, but the 0.01μF capacitors may have to be changed to give acceptable audio frequencies.

I shall be interested to hear of other uses which *Wireless World* readers can find for this device.

BRITISH BROADCASTING 1927-1939

The History of Broadcasting in the United Kingdom: Vol. II.—The Golden Age of Wireless. By Asa Briggs. Pp. 663+xvi; 54 illustrations. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 75s.

This volume of Professor Briggs's monumental history covers the period from 1927, when the British Broadcasting Company became the present Corporation, to the outbreak of war in 1939. During that epoch receiving licences rose from some two million to nine million. The B.B.C. was in process of consolidating itself into a national institution.

Though there is some emphasis on internal organization and policies, everything is covered—programme analyses and listener surveys, overseas broadcasting, the beginnings of television and preparations for war, with just enough of the technical background to help the story along as each development arises. Everything is fully documented and the history derives unique authority from the fact that the author had access to Lord Reith's diaries and private papers. Now we need no longer guess as to what really happened: Reith was Director-General for practically the whole period and played a dominant part in every important event. Naturally and properly, he overshadows the book.

Almost as soon as the possibilities of shortwaves for world-wide broadcasting became evident in the 1920s, accusations were levelled against the B.B.C. of dragging its feet in failing to set up a service of what was then called Empire Broadcasting. Criticism would have been largely disarmed had all the obstacles been fully known at the time. Money was one of the major troubles; the Dominions and colonies were not enthusiastic about contributing to the cost while the home government did not take kindly to the idea of the British taxpayer footing the bill. Reith objected in principle to the use of British listeners' money for the service. In 1930 he wrote in a private memorandum: "We are likely to be left with the baby to carry because everybody else is too selfish and we are too decent to let it drown." At that stage he was finding the Post Office unhelpful but later got its blessing and in 1932 a regular service was started from the multiple transmitter at Daventry. "The design of a broadcasting station to give effective world-wide coverage was a new concept."

The story of experimental 30-line television transmission (from 1929 to 1935) is largely one of protracted triangular negotiations between Baird interests, the B.B.C. and the Post Office, made still more involved by "the publicity seekers with whom Baird was to have so many complicated dealings" when television moved into the arena of high finance and speculation. When higher-definition television came on the scene the situation developed into a more straightforward contest between Baird's mechanical system and the "all-electronic" Marconi-E.M.I. Clearly, the B.B.C. and the Post Office as umpire were still making an effort to give Baird every chance. But the issue did not remain long in doubt; as Campbell-Swinton had forecast decades earlier, the "weightless cathode rays" were bound to win.

One could wish that someone with Briggs's powers of detachment, industry and ability to ferret out sources of information had arisen to write a history of the earliest days of radio communication in, say, the mid-1930s—when many of the pioneers were still alive, before records were destroyed and late enough to get the story in perspective.

H. F. S.

www.americanradiohistory.com

The Case of the Micromin Ostrich

ONE of the precepts which I learned at my mother's knee —or perhaps it was some other low joint—runs as follows:—

"If you can keep your head when all around you are losing their's—perhaps it's because you just don't understand the situation?"

Now, be it far from me to suggest that this is the reason behind the British electronics industry's attitude towards microelectronics. Perhaps it's a superb example of stiff upperlip manship or—horrible thought—the hypnotized immobility of a rabbit when confronted by a weasel. Whatever the cause, it seems to be remaining incredibly calm about the economic implications behind the advent of the new technology.

These thoughts stem from a point I tried to make last month, namely that microelectronics is not just another step towards the ultimate in miniaturization, but a brand new process of manufacture which owes nothing to the conventional art of making and assembling components. Its adoption demands completely different plant, completely new categories of engineering and completely new thinking.

Our industry has evolved over the years on a sort of twin-tub basis comprising two complementary units, equipment manufacturers and component manufacturers. To change the simile abruptly, this *mariage de convenance* has been established for a very long time, and the partners, despite the inevitable domestic tiffs, have been tolerably happy, with never a thought of separation, much less divorce, entering their heads.

But recently the plot has thickened. Enter the villain, microelectronics, to make a triangle of the situation; a triangle with a difference, however, because the interloper is, so to speak, bi-sexual, and is dallying with both partners.

This character, microelectronics, is fast becoming irresistible. To descend to our own terminology he/she is offering a considerable increase in equipment reliability and the mass production of circuits (as distinct from discrete components) in a shorter space of time and from a smaller manufacturing area. And as a dowry, these circuits come in a very small size; a feature which the computer and avionics boys (among others) are prepared to give their right arms for. All this at a cost which promises to be highly competitive.

One of the potential crises in all this is that in the micromin world the manufacturer of discrete components vanishes in a puff of silicon dioxide as soon as integrated circuits are mentioned. Or, rather, he and the equipment designer suddenly fuse into one. The 64,000 dollar question here is, in which camp is this composite being to pitch his tent?

There is much to be said on either side; no doubt it will be said in due course and the sooner the better, for the ostrich attitude never got anybody anywhere.

In default of concerted action, three individual courses are possible. One is that the equipment manufacturers turn out their own microcircuits (this is in fact already being done on pilot scales). If this becomes general, then the components industry will lose a lot of business, thereby finding itself in the middle of a large creek with no paddle and a hole in the bottom of the canoe.

Secondly, the converse could materialize, with the components industry making microcircuits for offer to the equipment people (again, this is already being done). But any mass attack will surely be mounted over the dead bodies of the equipment circuit designers, who regard it as a Divine Right of Kings to exercise absolute control over each and every individual component which goes into their designs.

The third potential course (and alas! only too possible) is the good old British compromise in which everybody makes microcircuits, the components people have a stab at the equipment market and the devil takes the hindmost. This would be an admirable way of squandering time, money and effort and of killing the entire industry stone dead in one fell swoop.

The advent of microelectronics is, in a sense, phase two of the transistor breakthrough, so might not its introduction be as orderly as that of the transistor? It might, but the two events are not wholly comparable. The invention of the transistor did not threaten the stability of the two-partner set-up; moreover, the higher price of transistorized equipment put an effective brake on the speed of changeover. Micromin could gather momentum much faster by being cheaper.

True, micromin techniques can't be used in all equipment, and so the equipment manufacturer who offers a diversity of products—and particularly large capital goods—it likely to experience a gradual transition over the years, with some departments in which micromin may never encroach. This in turn would ease the situation somewhat for the components people.

But the big boys are better able to look after themselves anyway. It is the little boys we have to worry about, and particularly those who market a small range of products which happens to make ideal micromin material. Even supposing that their pockets are deep enough to dig into for the very expensive new plant, they cannot reorganize overnight; neither can they immediately switch to the "new thinking" engineering which micromin demands. What will they do when such competitors as the U.S.A. and Japan launch into the field on a vast scale, as they are likely to do any moment? One thing is sure; if they do nothing they will cease to be competitors.

Has there been an all-out effort by the various electronics associations to resolve such problems? And if not, why not? This is not an idle question because upon the answer may depend the matter of whether you and I make a down payment for an electric lawnmower this spring or whether we have to hock the old one.

On the face of it, quite apart from the overall problems, the outlook for engineers seems mixed. The chap who will probably be best off in micromin is the newcomer from University with a mind relatively uncluttered by conventional techniques. The older engineer who has lived by conventional techniques for years may find the change more than a bit of a jolt, while those who firmly maintain that there's nothing to touch the thermionic valve will be well advised to rub their rabbit's foot and pray that micromin won't touch their sphere of activity until after their retirement.

For, no doubt about it, a micromin outlook has to be developed. The overall field of knowledge has to be very wide; in the U.S.A. there is a school of thought which says that the man who dreams up a project should design it and take it right through production, only stopping short of actually posting it to the customer.

With integrated circuits layout and breadboarding as discrete operations are certainly abolished. And design approach is different, too. You can't take a conventional circuit and micromin it, because present limitations make it necessary to "design out" as far as possible items that can't be coped with (line inductors and large capacitors). And it is not enough to design. It has to be done with a much more careful eye on the economics of the thing.

I could go on, but the Editor insists that I mustn't be exclusively depressive. So let's end on a bright note. It looks as if there will be a lot more girls around the industry when microelectronics really get going; which is another very good reason why the industry should get down to some solid co-operative planning without further delay.

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Commercial Literature

Signal Generator Comparison Chart.—A comparative list of signal generators operating below 100 Mc/s has been compiled by Marconi Instruments from the published literature of various manufacturers. Sixteen generators are included on this chart, which is available on request. Many technical details are given along with price guidance, dimensions and weight.
4WW 324 for further details

Broadcast Equipment.—Two items of transistor equipment that should interest broadcast engineers—an equalizer and a video amplifier—are described in new leaflets available from the broadcast and recording division of EMI Electronics Ltd., of Hayes, Middx. The equalizer (Type 920, leaflet No. B/920/2) is a twin-channel unit and the response at both ends of the frequency range can be lifted or lowered, and a peak can be introduced towards the centre of the range. The video amplifier (Type 254, leaflet No. B/254/2) contains two independent amplifiers, each of which provide two isolated 75-ohm outputs. Sync pulses can be added to one or both outputs of each amplifier.
4WW 325 for further details

Literature describing **transistor heat sinks** made by the D.T.V. Group, and others for which they are representatives, is now available from the Group's headquarters, 126 Hamilton Road, West Norwood, London, S.E.27.
4WW 326 for further details

Resistor Measurement.—Two new application bulletins, one covering the measurement of standard resistors with a differential voltmeter (AB-1) and the other covering the measurement of megohm resistances with a differential voltmeter (AB-2), have been published by the John Fluke Manufacturing Company Incorporated. Both of these are available in the U.K. from Livingston Laboratories Ltd., of 31 Camden Road, London, N.W.1.
4WW 327 for further details

Issue three of the **precision resistor chart** published by Alma Components Ltd., is now available from the company's headquarters in Park Road, Diss, Norfolk. Alma's "J" range of loose wound resistors and their metal film resistors are included in this edition.
4WW 328 for further details

Counter Details.—Circuit details of the Type TF2401 along with the facilities this electronic counter can offer are included in a publication Marconi Instruments have produced for this eight-digit, all transistor counter. The company's address is St. Albans, Herts.
4WW 329 for further details

Scattering Calculations.—A leaflet describing how electromagnetic scattering by bodies of any shape can be determined accurately by digital computer programmes developed by TRG Incorporated is now available from the instrument division of Claude Lyons Ltd., of 76 Old Hall Street, Liverpool 3.
4WW 330 for further details

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APRIL MEETINGS

Tickets are required for some meetings : readers are advised, therefore, to communicate with the secretary of the society concerned.

LONDON

1st. I.E.E.—"Ranger 8 spacecraft, with special reference to moon-shot camera systems" by B. P. Miller at 5.30 at Savoy Place, W.C.2.

5th. I.E.E. & I.E.R.E.—Colloquium on "The design of real time computer systems" at 2.30 at Savoy Place, W.C.2.

6th. I.E.E.—"The future impact of integrated circuitry on the work of professional engineers" by Dr. J. T. Kendall at 5.30 at Savoy Place, W.C.2.

7th. I.E.E.—"The mode of use and the assessment of precision coaxial connectors" by I. A. Harris at 5.30 at Savoy Place, W.C.2.

7th. I.E.R.E.—Papers on "Inertial navigational systems for airborne & shipborne uses" at 6.0 at 9 Bedford Square, W.C.1.

8th. Radar & Electronics Assoc.—"The big screen—film has a future in radar & electronics" by C. Barwell at 7.0 at the Mullard Theatre, Mullard House, Torrington Place, W.C.1.

8th. Television Soc.—"Advanced television technical problems in Japan" by Dr. K. Suzuki at 7.0 at the I.T.A. 70, Brompton Rd., S.W.3.

9th. I.E.E. & I.E.R.E.—Discussion on "Electromyography" at 2.30 at Savoy Place, W.C.2.

12th. I.E.E. & I.E.R.E.—"Solid circuits in computers" by N. Miller at 5.30 at Savoy Place, W.C.2.

13th. I.E.E.—Colloquium on "Problems and developments in electron linear accelerators and associated radio-frequency valves" at 2.30 at Savoy Place, W.C.2.

14th. I.E.E.—"Acoustics and telephone transmission—examples of the problems of human judgement" by H. S. Leman at 5.30 at Savoy Place, W.C.2.

14th. I.E.R.E.—"B.R.E.M.A. colour television home viewing tests" by R. N. Jackson, K. E. Johnson & B. J. Rogers at 6.0 at London School of Hygiene & Tropical Medicine, Keppel Street, W.C.1.

21st. I.E.R.E.—"Effect on the ionosphere of nuclear explosions" by F. L. Hill, at 6.0 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

26th. I.E.E.—"Standards and converters" by P. Rainger and E. Rout at 5.30 at Savoy Place, W.C.2.

28th. I.E.R.E.—"Synchronously tuned methods of harmonic and intermodulation distortion analysis" by D. E. O'N. Waddington at 6.0 at 9 Bedford Square, W.C.1.

29th. I.E.E.—Kelvin lecture: "The particles of modern physics" by Prof. R. O. Frisch at 5.30 at Savoy Place, W.C.2.

29th. S.E.R.T.—"Some problems of computer maintenance" by L. Baldwin at 7.15 at London School of Hygiene & Tropical Medicine, Keppel Street, W.C.1.

29th. Television Soc.—Fleming memorial lecture on "The specification of an adequate television signal" by Dr. R. D. A. Maurice at 7.0 at the Royal Institution, Albemerle Street, W.1.

30th. I.E.E.—"Equipment and the results of tests with the NIMBUS meteorological satellite" by Dr. N. E. Rider at 5.30 at Savoy Place, W.C.2.

BEDFORD

26th. I.E.E.—"Frequency-modulated stereo broadcasting" by G. D. Browne at 7.0 at the Bridge Hotel.

BIRMINGHAM

1st. S.E.R.T.—"Colour television" by B. J. Rogers at 7.30 at the College of Advanced Technology, Gosta Green.

6th. I.E.E. & I.E.R.E.—One-day symposium on "Electronics in industry—the next five years" at the University.

21st. Television Soc.—"Post office towers" by R. E. G. Back and P. J. Edwards at 7.0 at the College of Advanced Technology, Gosta Green.

26th. I.E.E.—"Birmingham Post Office radio relay tower" by S. G. Young at 6.0 at the James Watt Memorial Institute.

BRISTOL

12th. I.E.E.—"An introduction to analogue and digital computers—their differences and their uses" by K. C. Parton at 6.0 at Electricity House.

13th. Television Soc.—"Lasers in applications allied to television" by M. Wall at 7.30 at the Royal Hotel, College Green.

24th. I.E.R.E. and Inst.P.& Phys. Soc.—"Microstructure and physical properties of thin film" by Dr. A. J. Forty at 7.0 at the University Engineering Laboratories.

26th. I.E.E.—"Static switching—principles of electronic logic" by F. S. Brown and S. L. Hurst at 6.0 at the College of Science and Technology, Ashley Down.

CHELTENHAM

30th. I.E.R.E.—"Integrated circuits" by G. C. Padwick at 7.0 at North Gloucestershire Technical College.

COVENTRY

13th. I.E.E. & I.E.R.E.—"Data transmission in industrial processes" by H. Cox and J. Adderley at 6.0 at the Lanchester College of Technology.

EDINBURGH

1st. I.E.E.—Faraday Lecture on "Colour television" by F. C. McLean at 7.0 at the Usher Hall.

GLASGOW

7th. I.E.E.—"Fuel cells" by Dr. I. Fells at 6.0 at the Institution of Engineers & Shipbuilders, 39 Elmbank Crescent.

12th. I.E.E.—"Speech compression" by Dr. J. Swaffield, at 6.0 at the University of Strathclyde.

LEATHERHEAD

7th. I.E.E.—"The measurement of noise" by C. M. Brownsey, at 7.30 at the C.E.R.L.

LEEDS

14th. I.E.R.E.—"405/625 line conversion systems" by C. R. Longman at 6.30 at the University.

MALVERN

1st. I.E.R.E.—"Small high-fidelity loudspeaker systems" by K. F. Russell at 7.0 at Abbey Hotel, Abbey Road.

LIVERPOOL

14th. I.E.R.E.—"Field effect transistors and their applications" by C. S. den Brinker at 7.30 at Walker Art Gallery.

MIDDLESBROUGH

7th. I.E.E.—"Computers in control of processes" by Dr. D. N. Truscott at 6.30 at Cleveland Scientific Institution.

NEWCASTLE-ON-TYNE

4th. I.E.R.E.—"Pulse modulation systems" by J. Balmer at 6.0 at the Institute of Mining & Mechanical Engineers, Westgate Road.

6th. I.E.E.—Faraday Lecture on "Colour television" by F. C. McLean at 2.30 and 7.15 at the City Hall.

8th. I.E.E.—"Loudspeakers" by K. F. Russell at 6.30 at Rutherford College of Technology.

NOTTINGHAM

5th. S.E.R.T.—"The 625-line television system and its reception problems" at 7.15 at the East Midlands Gas Board, Lower Parliament Street.

7th. S.E.R.T.—"U.H.F. aerials" at 7.15 at the Midlands Design Centre, Mansfield Rd.

ST. ANDREWS

9th. I.E.E.—Symposium on "Application of semiconductor devices to biological electronics" at 11.0 at the University of St. Andrews.

STONE

26th. I.E.E. & I.P.O.E.E.—"Trunking and traffic principles of a P.C.M. telephone exchange" by E. Walker and W. T. Duerdoth at 7.0 at Duncan Hall.

CLUB NEWS

BEXLEYHEATH.—At the April 8th meeting of the North Kent Radio Society, Ian Lever will speak on "Television servicing" at 8.0 at the Congregational Church Hall.

HECKMONDWIKE.—Members of the Spen Valley Amateur Radio Society will visit the Royal Naval Reserve Communications Centre in Leeds on April 1st. A fortnight later C. R. Green, of Green & Davis, will talk about "commercial equipment" and on the 29th M. A. Browne will deal with "manned spaceflights." Meetings are held at 7.30 at the Grammar School, High Street.

LEAMINGTON SPA.—The fourth in a series of talks on radio theory will be given to members of the Mid-Warwickshire Amateur Radio Society on April 5th. It will cover valve performances. Fortnightly meetings are held at 7.45 at Harrington House, Newbold Terrace.

NORTH MIDLANDS MOBILE RALLY.—The University of Keele Radio Society will provide an "out-station" as part of the "talk-in" facilities for the Mobile Rally which will be held at Trentham Gardens on Sunday, April 11th. The Society's transmitters will be on 1960 kc/s and 145.4 Mc/s; call signs G3COY and G3SMD.

WELLINGBOROUGH. — "Transistorized TV" is the title of the talk to be given by K. Knibs at the April 1st meeting of the Wellingborough Radio Club which meets every Thursday at 7.45 at the Silver Street Club Room.

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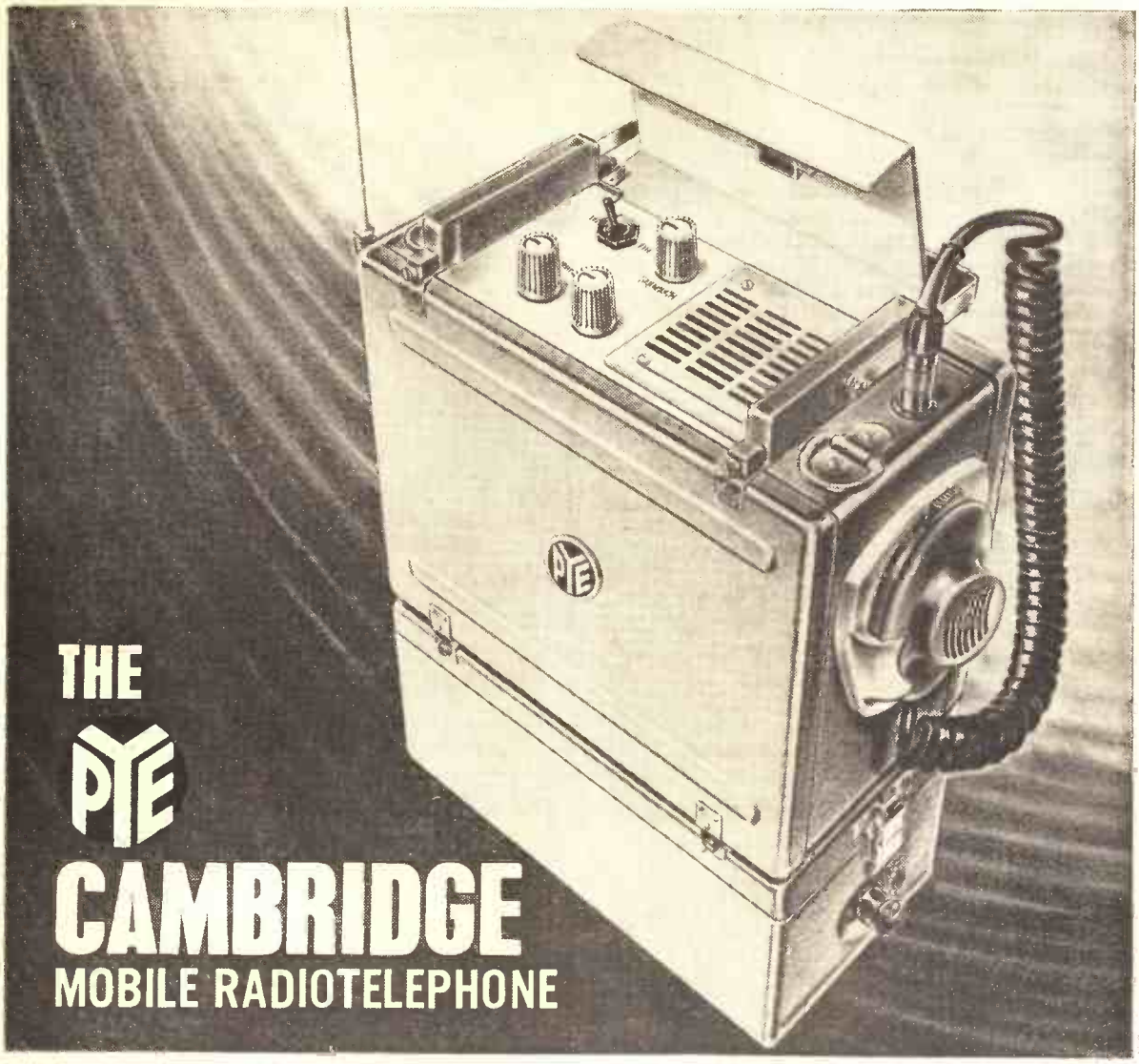

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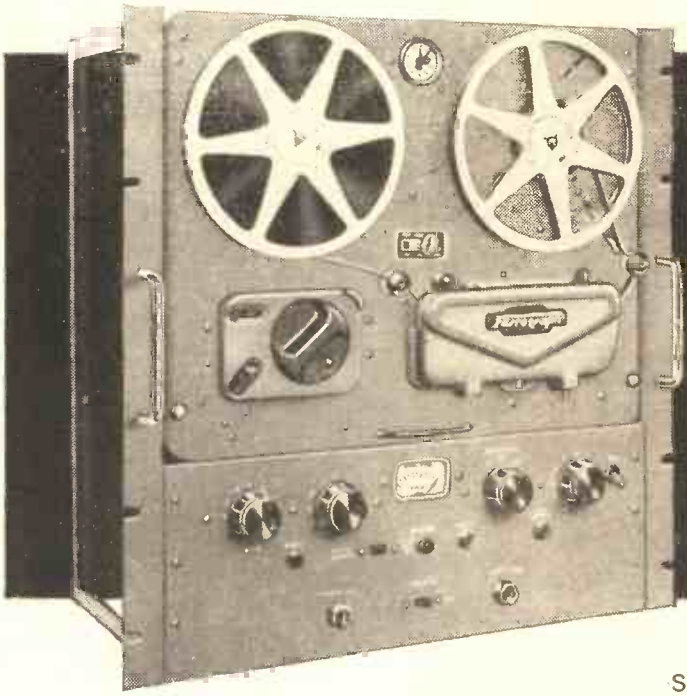

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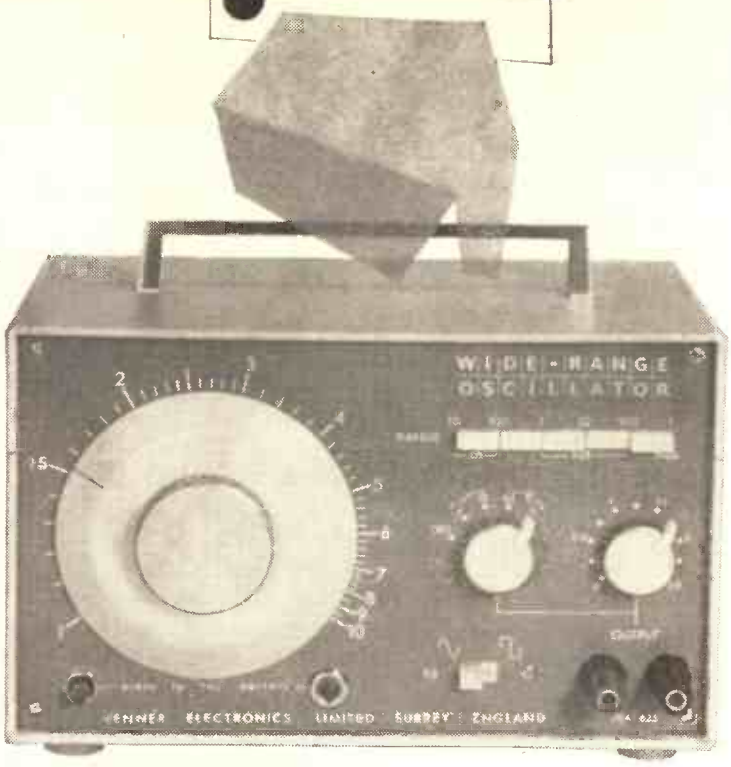

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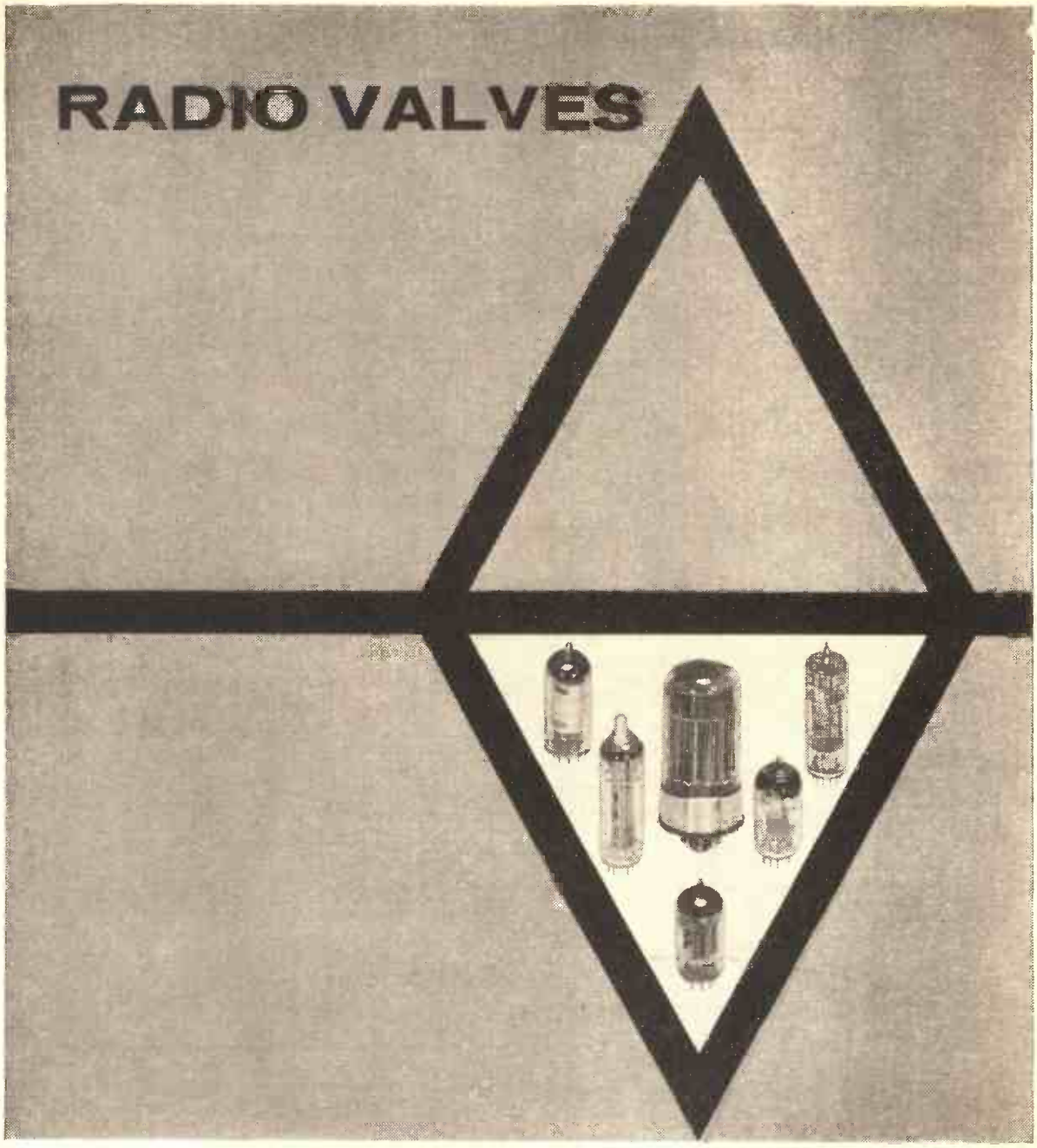

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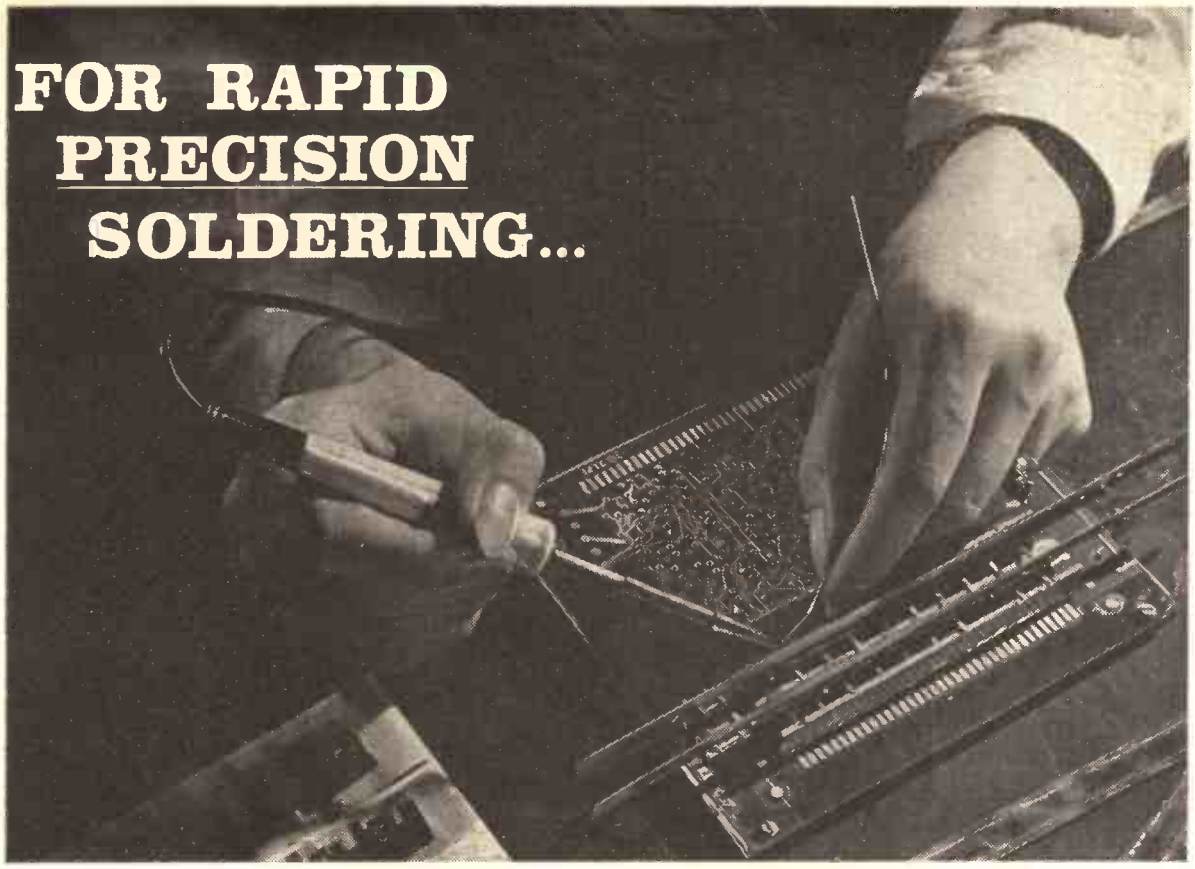

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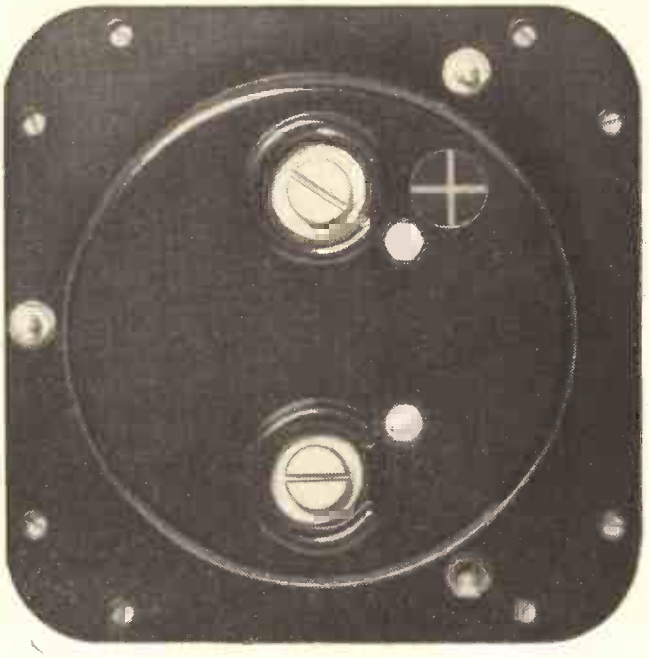

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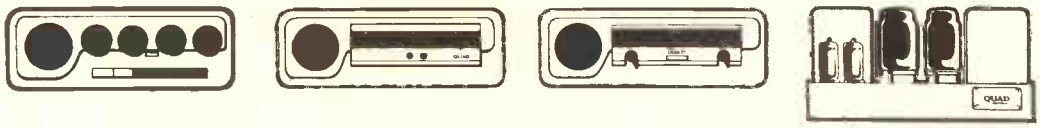

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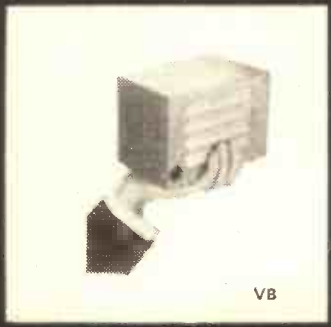
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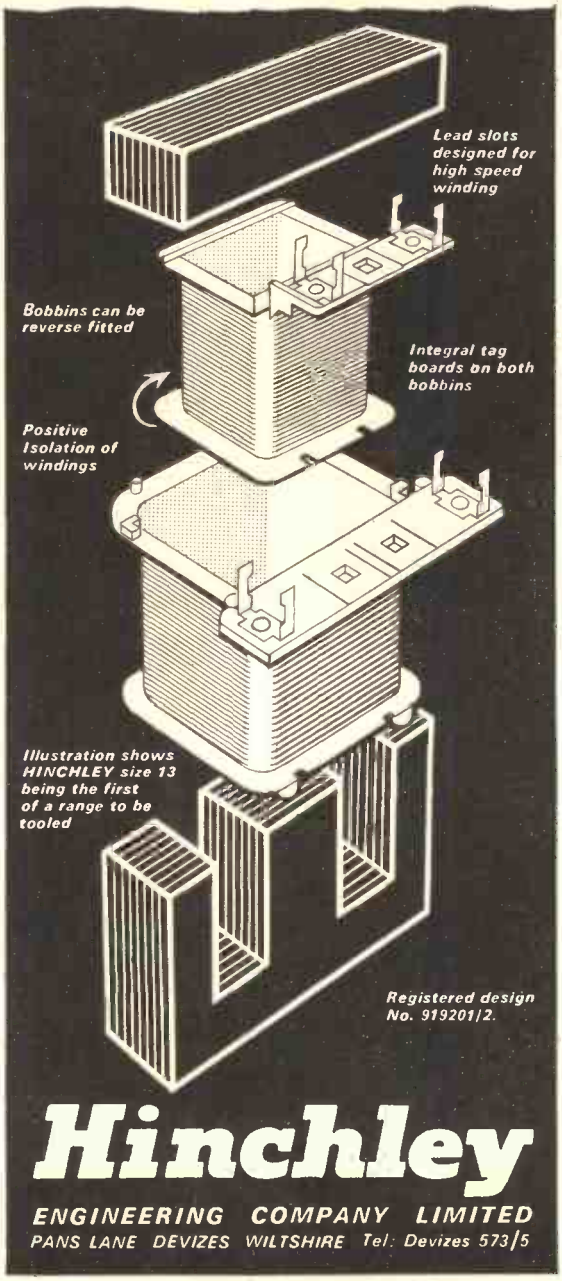

For sheer quality and reliability there has never been anything like it. In place of the normal winding two entirely separate bobbins slot together to produce transformers with these outstanding advantages:

1. The inner winding is completely isolated—insulation breakdown between windings becomes virtually impossible.

2. Internal soldered joints are eliminated. Absolute reliability is guaranteed. and full visual inspection can be carried out at the final test stage.

3. Impregnation is unnecessary. The very high grade plastics used do not absorb moisture and the working life of this type of transformer exceeds that of expensive paper insulated types even under tropical conditions.

Substantial Price Reductions

The unique design of Double Bobbin Transformers permits the use of semi-automatic manufacturing processes virtually independent of operators' skill. Thus we can offer substantial price reductions.

LEADERS IN THE DESIGN AND MANUFACTURE OF IRON-CORED COMPONENTS

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leaders in capacitor development for more than fifty years

DUBILIER

DUBILIER CONDENSER COMPANY (1925) LTD.
Ducon Works, Victoria Road, North Acton, London W3.
ACOrn 8671 (6 lines)

OVER FIFTY YEARS OF CAPACITOR EXPERIENCE HAS BEEN SQUEEZED INTO EVERY DUBILIER TANTALUM

Electrolytics by Dubilier cram outstanding new materials, the very latest constructional techniques and more than half a century of capacitor experience into units, in some cases, no more than three-sixteenths of an inch in length and less than an eighth of an inch in diameter. Power factor and leakage are low, shelf life high, temperature range enormously wide and performance quite remarkable. Tantalums in particular will operate at —80°C, resist both internal and external corrosion, whilst robust connectors practically eliminate risk of open-circuit failures.
Dubilier electrolytics range from multiple and special types right down to sub-miniatures and Tantalums, both foil and solid. If you would like to know more, give us a ring and we'll tell you exactly what's in them for you!

(------ AND SUB-MINIATURE ELECTROLYTIC)

*Tantalum approved to DEF 5134-2

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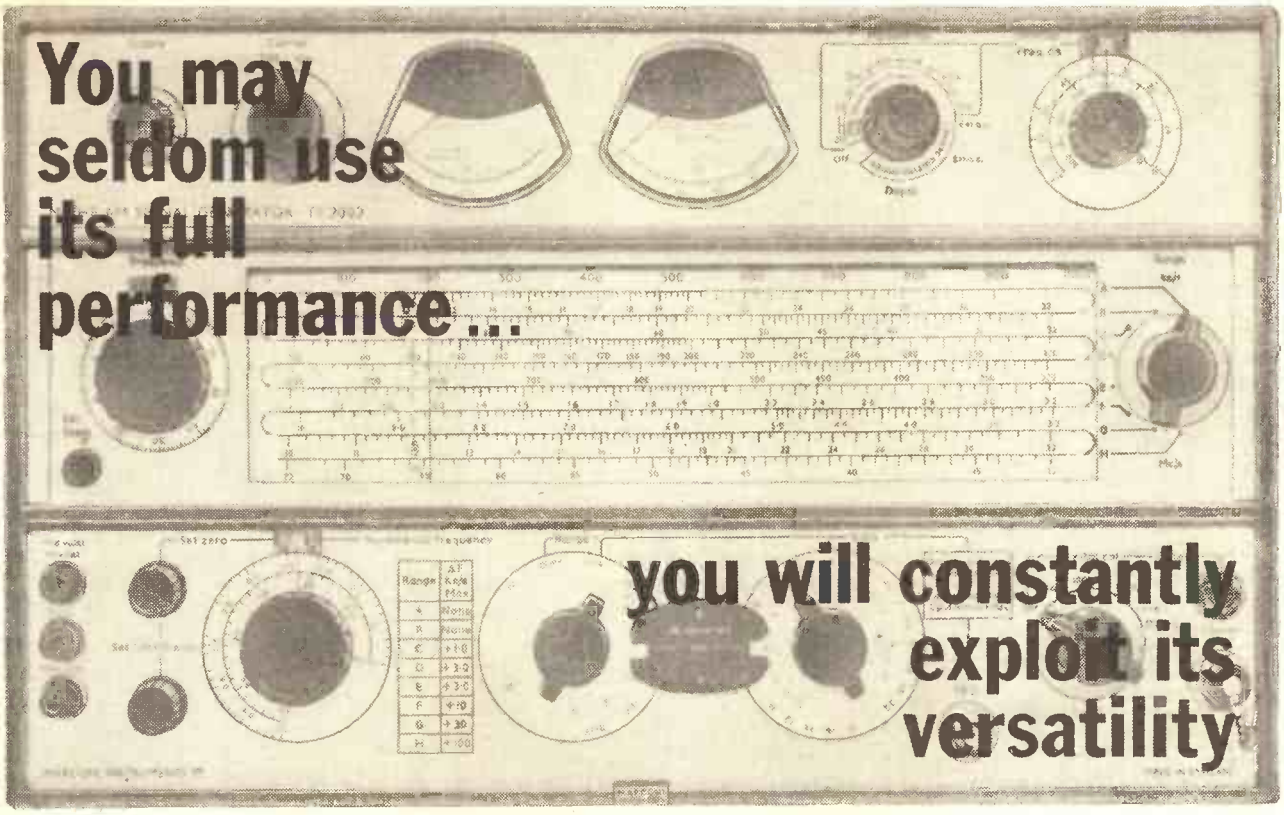

MARCONI INSTRUMENTS
SOLID-STATE

MF/HF AM SIGNAL GENERATOR

Type TF 2002

Once you are convinced that frequency, carrier level and modulation depth need not be interdependent . . . when you can flip the a.m. on and off without re-setting anything . . . when your signal generator remains tuned for hours without a tweak, yet tests are made so rapidly that stability scarcely matters . . . then you tend to become *inventive*. External shift facilities tempt you to use the TF 2002 as a sweep generator. *Don't resist the temptation*. You devise a new way to measure deviation with an a.m. instrument, and a quicker way to measure bandwidth. *Go ahead*—the TF 2002 is intended for people like you. No other single commercially available equipment combines the wide carrier frequency range, output facilities, modulation characteristics and all-round performance and versatility of Marconi Instruments MF/HF AM Signal Generator Type TF 2002.

Please write or telephone for full technical information. Also send for our new free booklet—Signal Generator and Receiver Measurements (Book I)—which deals with AM and FM equipments up to 100 Mc/s.

* Carrier frequency 10 kc/s to 72 Mc/s in 8 ranges
* Discrimination of the order of 0.005% of carrier
* Crystal calibration 1 Mc/s, 100 kc/s and 10 kc/s, also 1 kc/s check points
* Output 0.2 μV to 2V r.m.s.
* Attenuators 140 dB in 1 dB steps
* AM up to 100% depth. Internal oscillator 20 c/s to 20 kc/s

A GOOD NAME FOR GOOD MEASURE

MARCONI INSTRUMENTS

Marconi Instruments Limited
St. Albans, Hertfordshire, England
Telephone: St. Albans 59292 Telex 23350

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TC279

...GOODMANS demonstration
of HIGH FIDELITY LOUDSPEAKERS

at the International Audio Festival and Fair, April 22-25, 1965, The Hotel Russell, London, W.C.1. Demonstration Room 249. Trade Room 250, Stand 68.

Hear the excellence of Goodmans High Fidelity for yourself... in natural surroundings... just like your own home. Visit the Goodmans demonstration room at the Audio Festival and be convinced that your best choice for High Fidelity is Goodmans—naturally.
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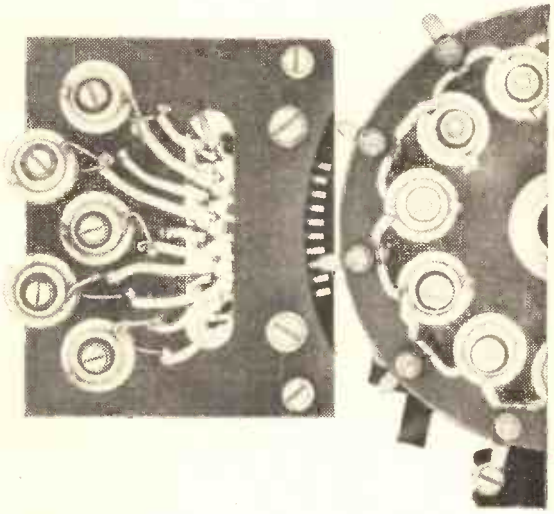
Full Marks



Problem: Design and build a unit to provide continuously variable resistance from 0 to 1000Ω with high resolution and first class handling qualities. The effect of residual capacitance is of great importance, and must remain constant in every position of the control. No wire-wound potentiometer has adequate resolution and handling qualities.

Solution: A 110-position turret mechanism carrying ten precision 100Ω resistors disposed symmetrically: peripheral contacts ingeniously arranged to provide ten equal intervals in each 100Ω step by selecting one to nine series units from a bank of precision 10Ω resistors: a potentiometer operated by a co-axial drive through the centre of the turret mechanism. All special electrical and mechanical components are made in the factory. Constant capacitance is achieved by the symmetry of the design. Resolution and handling qualities are excellent.

This neat and original solution to a complex switching problem is a feature of Marconi Instruments Type TF 1515 Universal Bridge. L, C and R readings are given on a single direct-reading dial, with coarse and fine concentric controls providing steps of 1% of the nominal range with continuous interpolation between steps. Classical bridge circuits are used in the TF 1515; but the 'grand concept' of a measuring instrument, the ease and rapidity of operation, the inventiveness, the experience, skill and craftsmanship are characteristic of a Marconi Instruments design team. The overall accuracy of this bridge is ± 0.25% of reading: the discrimination better than ± 0.02% of range maximum.

In addition to the Type TF 1515, the range of Marconi Instruments bridges and Q-meters includes a versatile and inexpensive 1% Universal Bridge Type TF 2700; an 'In Situ' Bridge capable of measuring wired components in the presence of heavy shunting, Type TF 2701; and a Circuit Magnification Meter, Type TF 1245, with alternative oscillators and a wide range of accessories providing Q measurements from 5 to 1000 at frequencies from 1 kc/s to 300 Mc/s.

The latest edition of our handbook 'Impedance Measurements with a Q-Meter' is now available. It is one of a series of informative technical publications to be issued by Marconi Instruments in 1965. Please send for your complimentary copy.

A GOOD NAME FOR GOOD MEASURE

MARCONI INSTRUMENTS

MARCONI INSTRUMENTS LIMITED
ST. ALBANS · HERTFORDSHIRE · ENGLAND
TEL: ST. ALBANS 59292 · TELEX 25350

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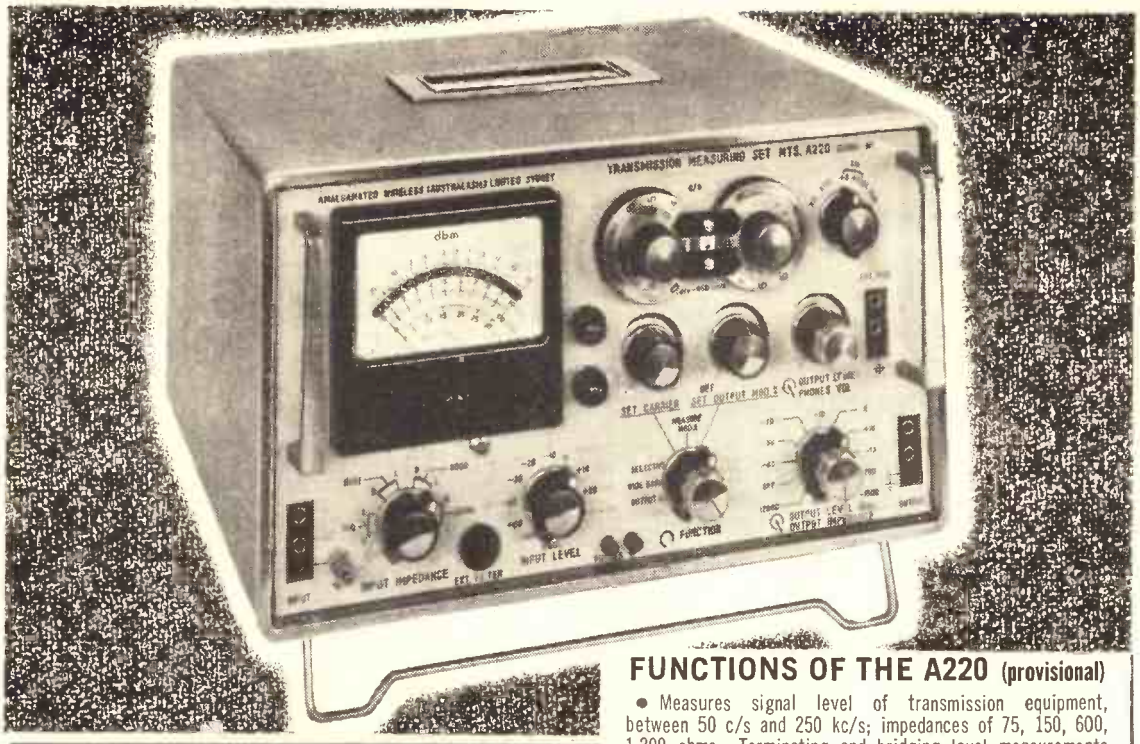

THE AWA TRANSMISSION MEASURING SET——A220

An accurate, portable instrument for the evaluation of audio and carrier frequency systems.

- Compact, transistorised and ruggedly constructed, the instrument is ideal for field or station use.
- All major circuits are plug-in epoxy glass-fibre printed boards.
- Accuracy and high-stability have been retained by the use of tantalum electrolytic capacitators and deposited metal-film resistors.
- Unit may be operated from A.C. Mains, external D.C., or internal rechargeable cells.

For further particulars, please contact Engineering Products Division.

FUNCTIONS OF THE A220 (provisional)

- Measures signal level of transmission equipment, between 50 c/s and 250 kc/s; impedances of 75, 150, 600, 1,200 ohms. Terminating and bridging level measurements with balanced input.
- High-impedance voltmeter (unbalanced), 50 c/s to 650 kc/s. 1 Mohm input, sensitivity 10 mV, F.S.D.
- A balanced frequency-selective voltmeter to measure pilot carrier level and "Tone-on-channel" selection. Bandpass 100 c/s.
- Measures individual channel levels (end-to-end) between 200 c/s and 3.4 kc/s.
- Wien-bridge, sine-wave oscillator, frequency continuously variable over range 100 c/s to 630 kc/s. With associated amplifier outputs to +13 dbm in 75, 150, 600, 1,200 ohms (balanced).
- Wien-bridge, oscillator amplitude, modulated by internal oscillator at 820 c/s or by external tones between 200 c/s and 3.4 kc/s.
- High-sensitivity measurements (–80 dbm for transmission level and noise measurement).
- Meter indicates modulation percentage on carrier channels (8 kc/s to 250 kc/s).
- Weighted noise measurements (with optional external plug-in unit) to C.C.I.T. Specification or other network if required.
- Simulates broadband carrier channels with a.m. modulation.
- Wave analyser measures harmonic distortion and intermodulation products down to 0.1%.
- Amplitude modulation monitor, 0 to 80%.
- Measures the bandpass characteristics of filters.
- Provides output for Pen recorder (0.1 mA 1,000Ω) or head receiver for listening tests.

Dimensions and Weight:
Height: 8 inches 20.3 cm. *Width:* 14 inches 35.5 cm. *Depth:* 12.5 inches 31.75 cm. *Weight:* 20 lbs. 9 kg. (approx. including power supply).

AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED

47 YORK STREET, SYDNEY — 2 0233

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EP7-65

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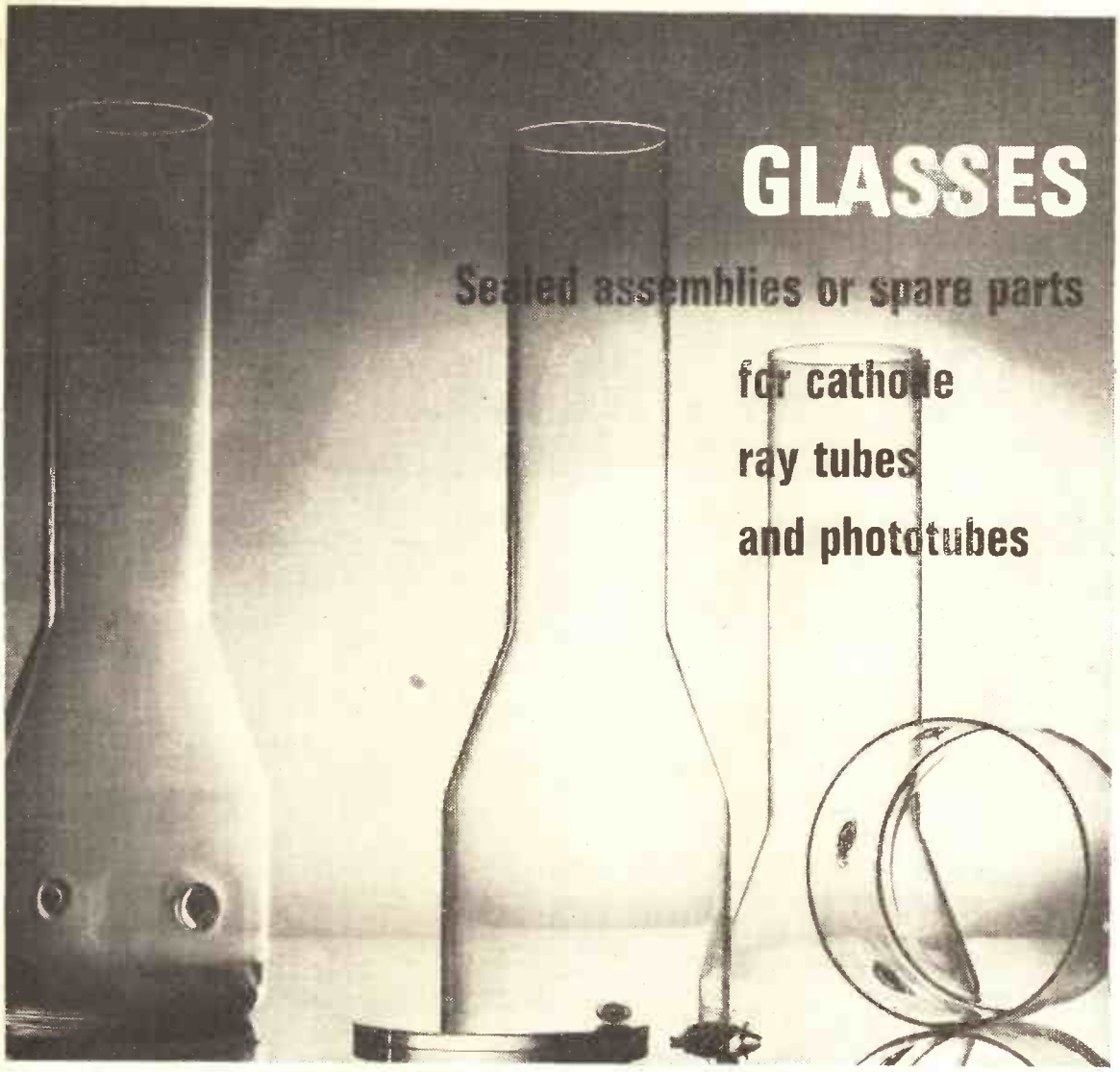

SOVIREL have great experience in the techniques of glassworking and devote a large part of their production facilities to the manufacture of components or assemblies for the electronic tube industry.

Examples are :

- Image converter tubes
- Image storage tubes
- Memory tubes
- Photomultipliers
- TV camera tubes
- Light amplifiers

SOVIREL recommend, from among their glasses in current production, the four types listed opposite. These are particularly suitable for the manufacture of cathode ray tubes and phototubes owing to their perfect sealing compatibility to each other and to the currently-used metals or alloys.

SOVIREL quality control guarantees high dimensional precision and perfect optical quality.

GLASSES FOR FACEPLATES

S 801-40 and S 801-51 (7056)

Optically perfect - stable
Supplied rough or with polished surfaces.

GLASSES FOR ENVELOPES, FEET, PUMPING TUBULATIONS AND FOR HIGH TENSION INSULATION

S 740-01 seals to tungsten

S 747-01 seals to molybdenum and to suitable Fe/Ni/Co alloys.

DAMOUR-INDUSTRIE

DIVISION ELECTRONIQUE-TELEVISION **SOVIREL**

30-304

27, rue de la Michodière, Paris 2e - France - Tél. : 742.23.49

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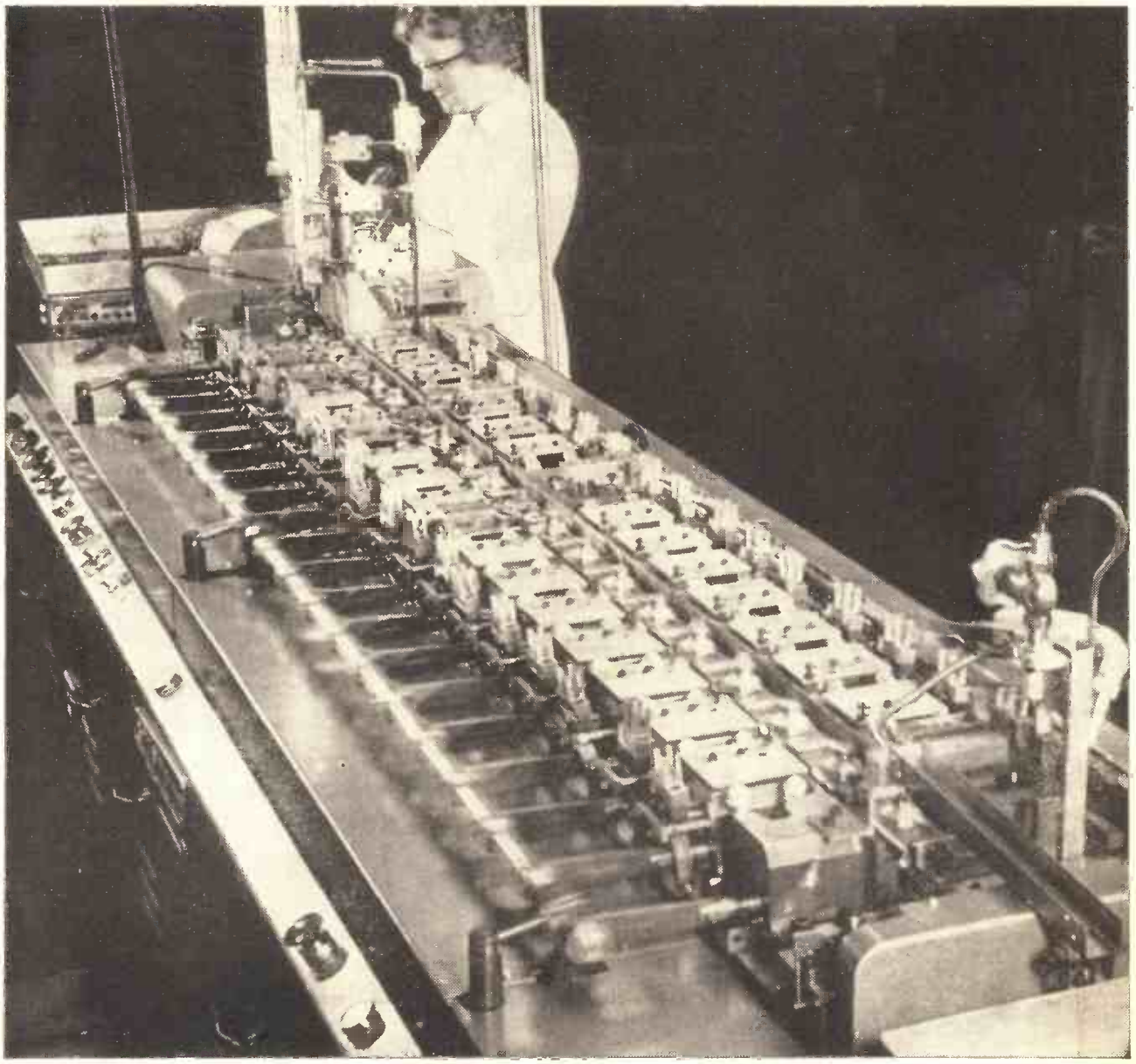
JIGGING & TWISTING the Brimar way



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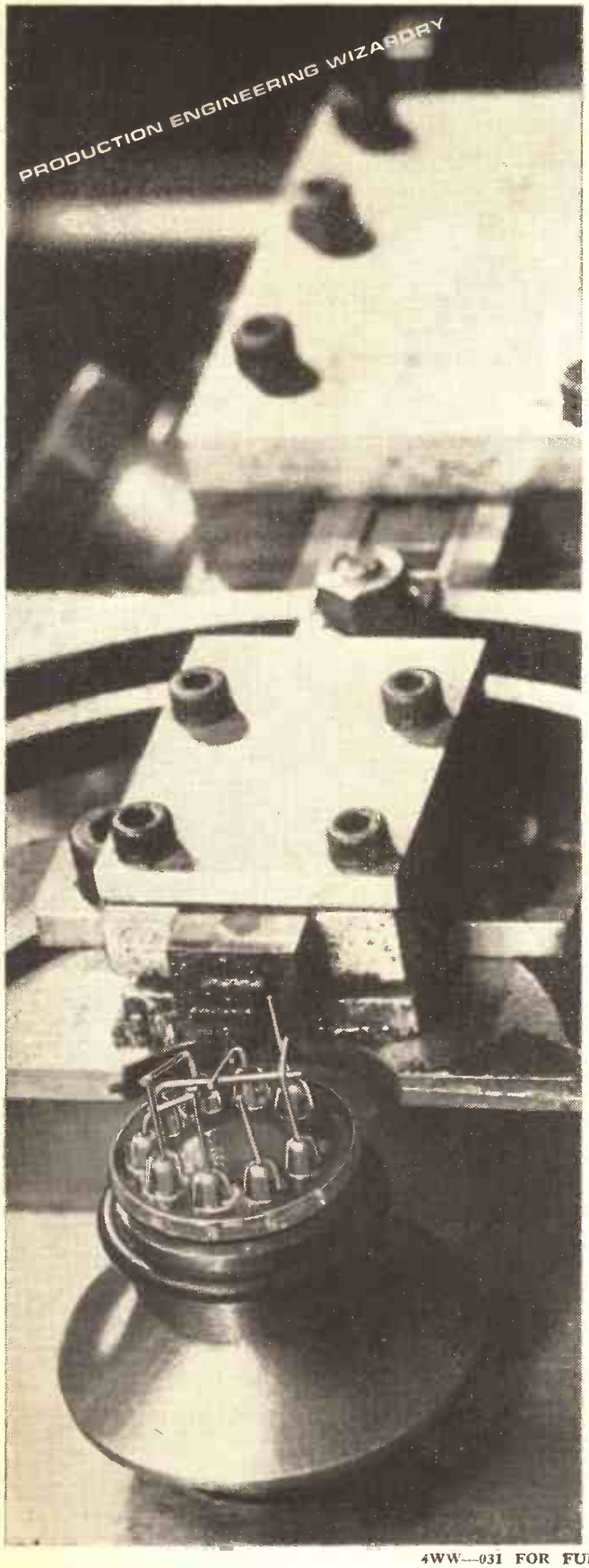

BRIMAR

To make absolutely certain that stems mate accurately with valve electrodes prior to welding, stem wires are sent on a jigging, twisting run through the 34 stations of the Brimar in-line cropper and bender.

Here, wires are automatically selected, bent and cut in a variety of complex ways with unvarying precision, a tiny claw engaging with each wire as the arm thrusts forward to ensure a clean bend at the point of contact.

At the end of the run, the stem is eased from its seating and puffed gently by compressed air into a waiting tray – a Brimar valve part as near perfect as modern machinery (and human ingenuity) can make it!

This ingenious in-line cropping and bending machine was designed exclusively by Thorn-AEI development and production engineers.

RADIO & ELECTRONICS COMPONENTS SHOW

OLYMPIA

STAND 325 GRAND HALL

THORN-AEI RADIO VALVES & TUBES LTD

HEAD OFFICE:
155 Charing Cross Road, London WC2. GERrard 9797

EXPORT DIVISION:
Thorn House, Upper St. Martin's Lane, London WC2.

TPA 3

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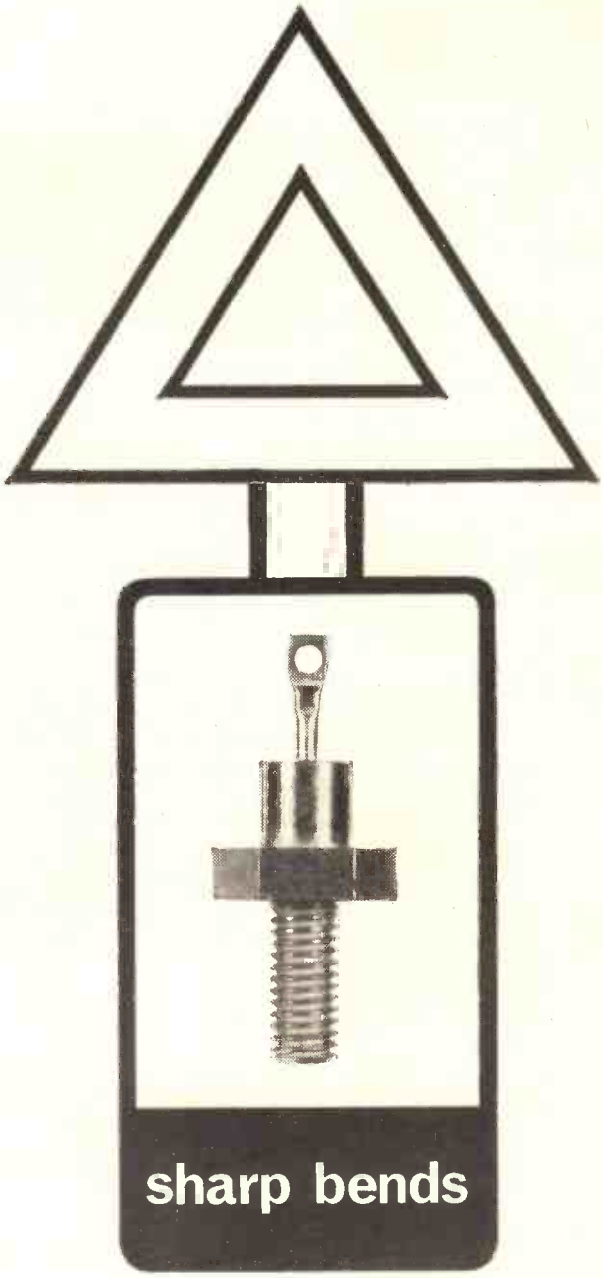

Over 300 of them: wicked square corners that can't be cut. There's one in the performance curve of every IR zener. Ask for details of zeners from 400mW to 50W, and 3.6V to 200V. The 1W and 10W range is fully type approved.

IOR INTERNATIONAL RECTIFIER

Immediate off-the-shelf delivery from IR distributors—phone

COLCHESTER 6173 · CRAWLEY 28700 · GLASGOW DOUGLAS 8671 · (LANCS) TODMORDEN 602 · LEEDS 35111
LEICESTER 68561 · (LONDON S.E.27.) GYPSY HILL 6166 · (MIDDLESEX) SKYPORT 1314 · PORTSMOUTH 20465

INTERNATIONAL RECTIFIER CO. (GREAT BRITAIN) LTD · HURST GREEN · OXTED · SURREY · TELEPHONE OXTED 3215 · TELEX RECTIFIER OXTED 8819

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HIGH VOLTAGE MEASUREMENT—WITH NO STRINGS

Almost every engineer can remember being taught at school the principle of the electrostatic voltmeter.

But the textbooks sometimes leave one with the impression that this type of movement is fragile and unreliable, suitable only for bench use in the laboratory.

In fact, Ernest Turner have for many years been manufacturing panel meters with electrostatic movements in a wide selection of ranges, and they have been found no less robust and reliable than other types of movement.

An electrostatic voltmeter, of course, is the answer to many problems in the field of high voltage measurement. Its primary, and best-known, feature is that the load placed on the measured circuit is negligible. For d.c. measurements the meter is effectively an open circuit and on a.c. it presents a small, measureable capacity.

It operates without the string of series resistors associated with moving coil meters for measurements in the kilovolt range, and a further minor advantage is that accuracy is not impaired by external magnetic fields since there is no magnetic material in the movement.

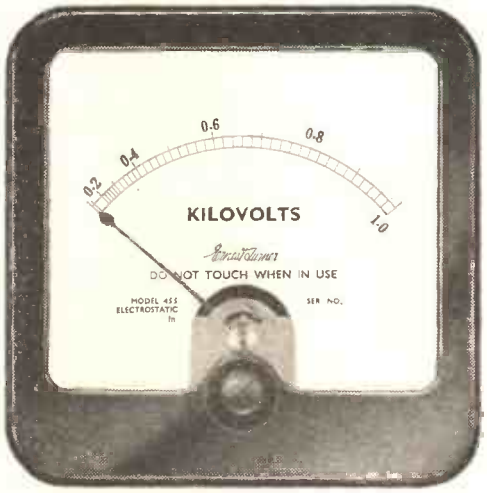
The limitations of electrostatic meters are few, but fundamental. They can only be used for measuring potential, and the lowest full scale deflection possible under normal conditions is a few hundred volts. The scale tends towards non-linearity at the lower end, but this point is offset for some applications by the ease with which we can arrange local scale expansion where necessary.

Ernest Turner electrostatic meters are available in round cases with scale lengths from 2¼in. to 5¾in. and in square cases with 2⅜in. and 3⅜in. scale lengths. Maximum range depends on the physical size of the case; in the largest size we can supply instruments up to 20kV. d.c. or 15kV. a.c. f.s.d.

Naturally, all Ernest Turner electrostatic meters are individually calibrated, in fact they are hand built in order to achieve the well-known Ernest Turner standard of reliability. We offer a full service of variations to special order—dial markings, special scaling, choice of pointer shape and so on—in fact, every facility which is at the customer's disposal in respect of other movements.

Owing to the factor of individual manufacture, delivery is being quoted at 10–12 weeks, but prototypes can be produced more quickly by special arrangement.

The Ernest Turner Page



The Model 455 electrostatic voltmeter is illustrated above approximately half full size. It is the larger of two Ernest Turner rectangular instruments which can be fitted with electrostatic movements, and is available in ranges up to 5kV.

Other Ernest Turner instruments which can be fitted with electrostatic movements include Models 505, 23, 119, 319 and 32, the latter being produced in ranges up to 20kV.

Full details of all these instruments are given in Catalogue 85/25, available on request.

ERNEST TURNER ELECTRICAL INSTRUMENTS LTD

CHILTERN WORKS · HIGH WYCOMBE · BUCKINGHAMSHIRE · ENGLAND

Tel: High Wycombe 1301

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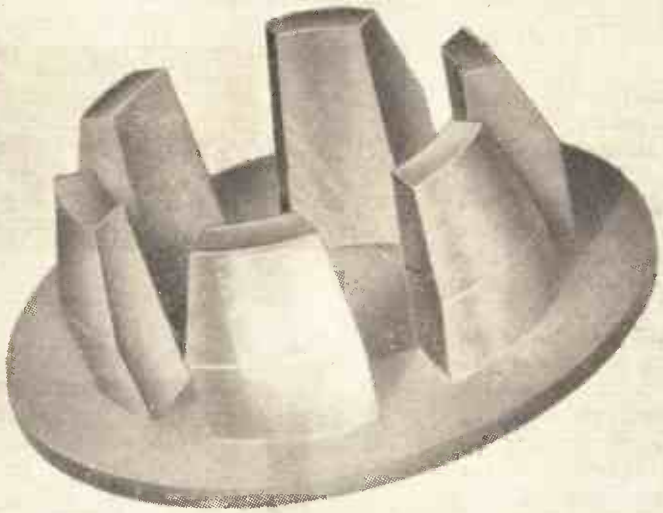


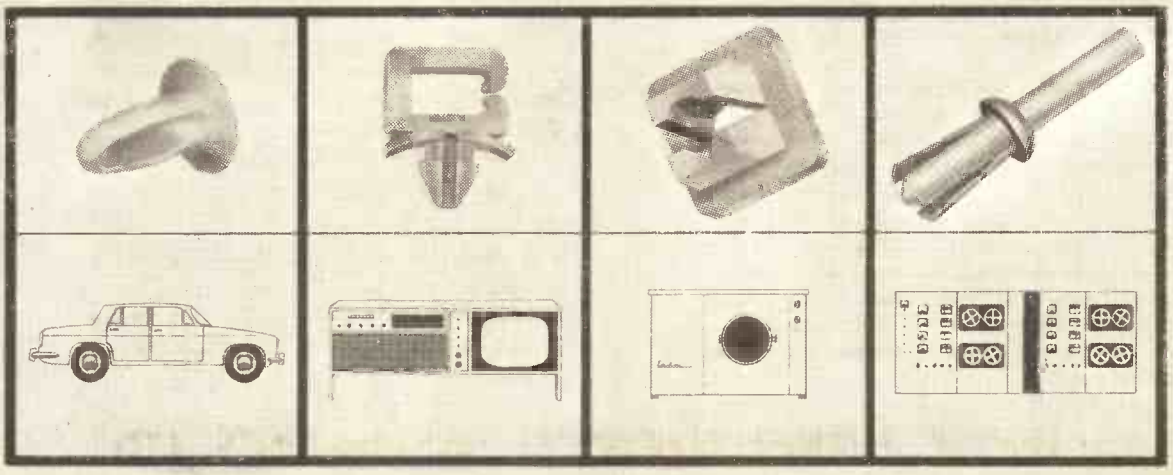
Fasten onto 'FASTEX'

With unshakable confidence!

The unique range of 'FASTEX' plastic fasteners provide a POSITIVE answer to all assembly problems, where cost reduction and fixing simplicity is of prime importance.

Consider the 'FASTEX' facts:— **CORROSION RESISTANT • IMPRESSIVE INSULATION • MINIMUM FIXING TIME • MAXIMUM UNSHAKABLE GRIP.**

If you appreciate the advantages of combining several operations into one, cutting assembly costs *and* producing a higher quality product; contact one of our problem solving Sales Engineers. If he cannot immediately help solve your particular fastening problems, our development department will. Consult 'FASTEX' now, or at least write for free samples and further information, you'll be glad you did.



FASTEX itw

ITW LIMITED, Fastex Division, 647 Ajax Avenue, Trading Estate, SLOUGH. Bucks. Tel: SLOUGH 27441

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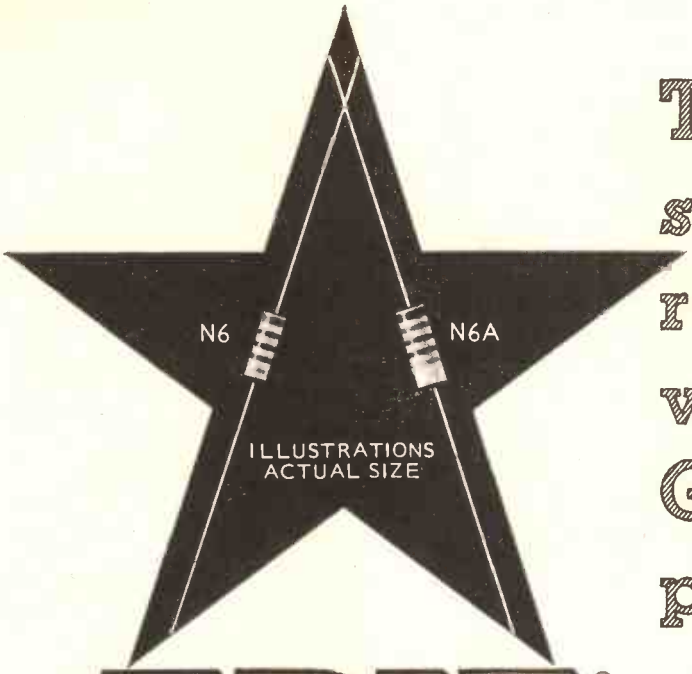

The *sub-miniature* resistors with the GREAT performance...

ERIE®

Type N6 and N6A

INSULATED HIGH STABILITY RESISTORS

★ The world's smallest ceramic insulated resistors.

★ Special ceramic core to ensure perfect bonding of carbon film resulting in low inherent noise and excellent life characteristics.

★ Special "heavy carbon film" to ensure uniform high standard of stability and reliability throughout resistance range.

★ Ceramic encased to ensure maximum protection from mechanical shock and adverse climatic conditions.

The N6 is Defence Approved to DEF 5112A.

BRIEF SPECIFICATIONS

STYLE	N6	N6A
Length, maximum	0.359in	0.438in
Diameter, maximum	0.131in	0.162in
Resistance range ohms	10 to 100KΩ	10 to 1MΩ
Wattage rating	⅛ Watt 70°C	⅛ Watt 70°C
Voltage rating	200V d.c.	200V d.c.

ERIE® ELECTRONIC COMPONENTS

®Registered Trade Mark

ERIE RESISTOR LIMITED GREAT YARMOUTH NORFOLK Telephone 4911 Telex 1720

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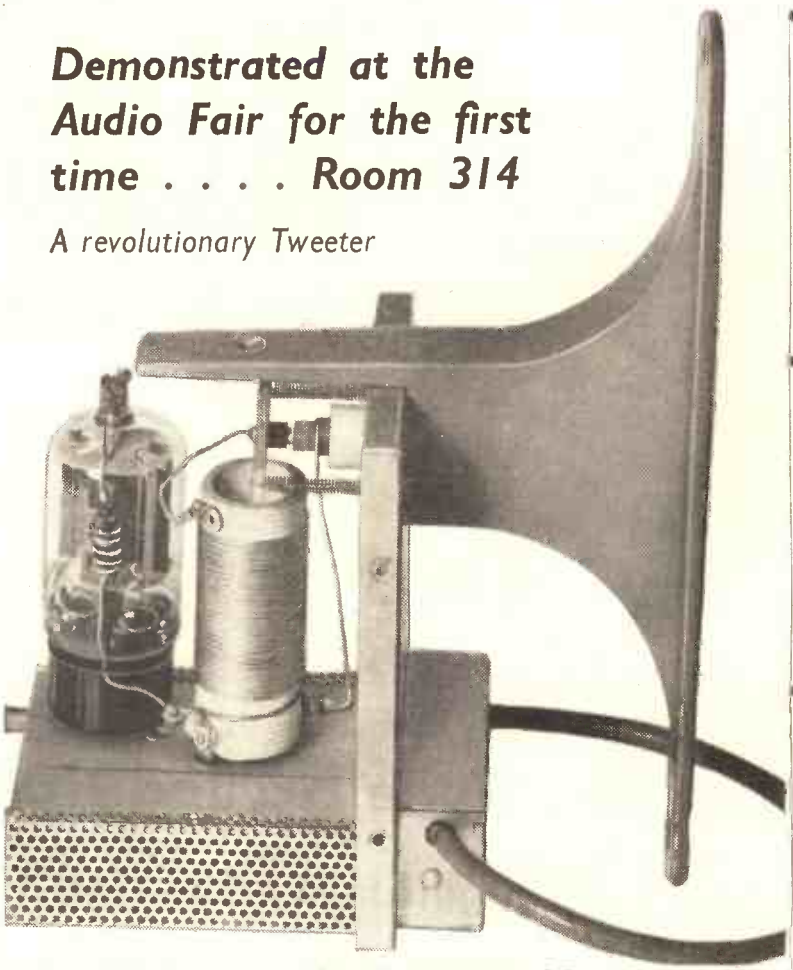
Demonstrated at the Audio Fair for the first time . . . . Room 314

A revolutionary Tweeter



THE NEW SUPERB IONOFANE LOUDSPEAKER

The IONOFANE operates on the Ionophone principle invented by Klein of Paris and is covered by British Letters Patent No. 756546.

It is a high frequency loudspeaker having a perfectly uniform response from 3 to 30 kilocycles, quite free from resonances and colourations and with perfect reproduction of transients.

It is fully guaranteed.

FANE ACOUSTICS LTD

HICK LANE - BATLEY - YORKSHIRE

Enquiries for these Speakers including the Wholesale and Retail Trade may be sent direct to
FANE ACOUSTICS LTD., BATLEY, YORKSHIRE
or to LINEAR PRODUCTS LTD., ARMLEY, LEEDS

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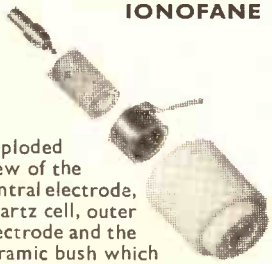
THE HEART OF THE IONOFANE



Exploded view of the central electrode, quartz cell, outer electrode and the ceramic bush which forms the first section of the horn.

MODEL 601
The basic H.F. unit ready for building into a speaker assembly. It will handle the treble of 20 watts of music. **28 Gns.**

MODEL 602
The basic Ionofane H.F. unit, together with a special 5″ mid range unit, cross-over and provision for connection to an existing bass unit of up to 20 watts capacity. **45 Gns.**

MODEL 603
A full range speaker assembly of the highest quality consisting of the Ionofane H.F. unit, new 5″ mid range and new 15″ bass unit. Will handle up to 20 watts. **75 Gns.**

WRITE NOW FOR ILLUSTRATED CATALOGUE

STB2·STB2·STB2

ANOTHER BRILLIANT DESIGN from BRENELL

The STB2 is a masterpiece in mechanical engineering and electronic circuitry. It is a versatile mono/stereo tape recorder and has been designed with high fidelity stereo installations particularly, in mind.

SPECIFICATION (STB2/5/2)

It has all the standard Brenell features of 4 tape speeds, frequency correction at all speeds, three Papst outer rotor motors, pause control, monitoring and superimposing, 8¼″ dia. reels, fast rewind, etc., plus—adjustable attenuators on all input channels to ensure perfect matching with all auxiliary equipment · dual concentric recording level and playback level controls · cathode follower output four channel mixing on mono programme sources · twin recording and twin playback pre-amplifiers · comparison of original and recorded signal · adjustable bias level · recording facilities for 1/2 and 2/2 track · playback facilities for 1/2, 2/2, 1/4 and 2/4 track sound on sound facilities · two edgewise meters for recording level, tape output level and bias level · optional extra:- stereo power amplifiers and monitoring speakers.

ALTERNATIVE MODEL STB2/510/2 has special deck to accommodate 10½″ N.A.B. reels.

Please write for full details to the sole manufacturer:-

INTERNATIONAL AUDIO FAIR
STAND No. 12
DEMONSTRATION ROOM 337

Brenell

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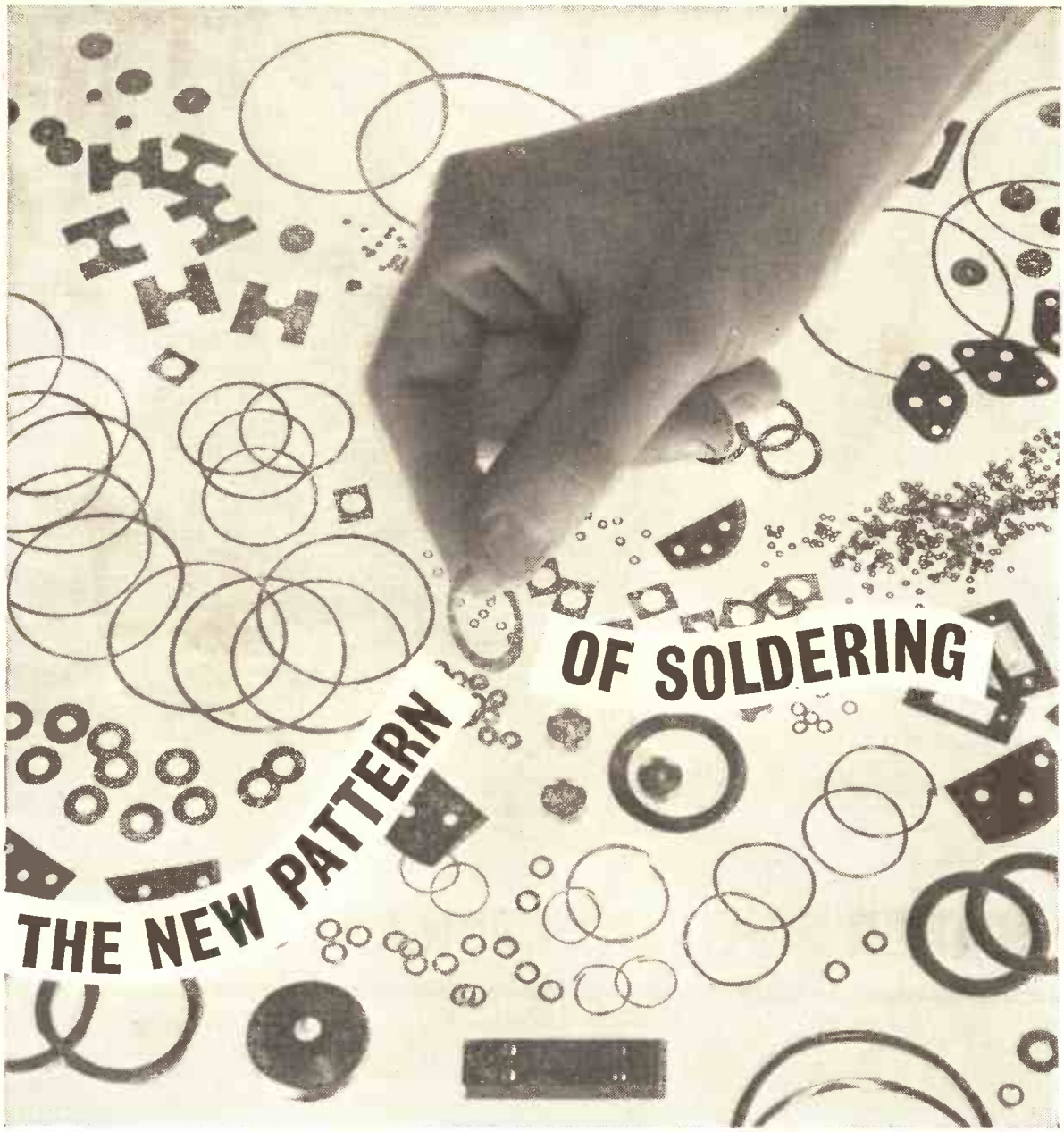
BRENELL ENGINEERING CO. LTD.

231/5 Liverpool Road, London, N.1.
Telephone: NORth 8271 (5 lines)

GD 998



Enthoven Preforms. Solder preforms make for faster, more accurate and therefore *cheaper* soldering. Enthoven are leaders in the design and manufacture of solder preforms, and offer a wide range of alloys, both cored and solid, in the form of rings, washers, discs, shims, strips and ribbon.

Enthoven are always ready to discuss any industrial soldering problem, and, if necessary, to design special preforms in the light of your requirements and of their long experience of precision soldering techniques.

ENTHOVEN SOLDERS LIMITED

Sales Office & Works: Upper Ordnance Wharf, Rotherhithe Street, London, S.E.16. BER 2014
Head Office: Dominion Buildings, South Place, London, E.C.2. MONarch 0391

This free booklet describes the complete range of Enthoven Solder Products . . . preforms among them. Ask for a copy.

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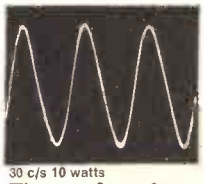
TWO NEW CABINET MODELS

OF OUTSTANDING PERFORMANCE from WHARFEDALE

Fitted with new type of 12″ bass units with **NEOPRENE SURROUND** giving remarkably clean bass. Both cabinets are of modern and attractive appearance, designed by Industrial Artist, Robert Gutmann, F.S.I.A. **Both models to be introduced and demonstrated at the 1965 Audio Festival and Fair, at the Russell Hotel, London.**

W2-DOVEDALE

This is a modern version of the W2 at a rather higher price. Open baffle resonance of special 12″ unit is remarkably low at 15/18 c/s.



30 c/s 10 watts

The waveform shows a clean note at 30 c/s with 10 watts input.

Units:
WLS/12/Neoprene. 13,000 gauss.
Super 5, cloth surround. 14,000 gauss. Crossover frequency; 1,000 c/s.
Freq. range; 25-17,000 c/s. Impedance; 12/15 ohms.
Power handling capacity; 15 watts rms. 30 watts peak.
Size; 24″ x 14″ x 12″. Weight; 37 lb.
Finish; Zebrano veneer, wax polished.
Fitted treble control in back panel. PRICE **£31.10.0.**

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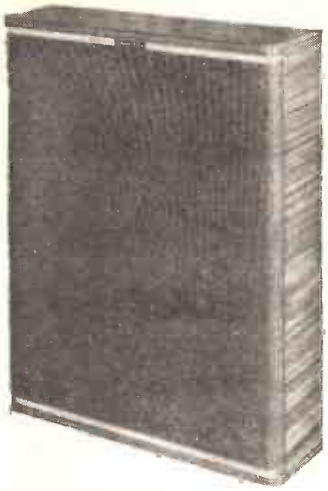

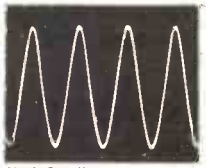

40 c/s 8 watts

In spite of being only 6¼″ deep, this attractive design will handle 8 watts at 40 c/s without distortion, as shown in waveform.

Open baffle resonance of 12″ unit is 20/23/c/s.

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Frequency range; 30-15,000 c/s.
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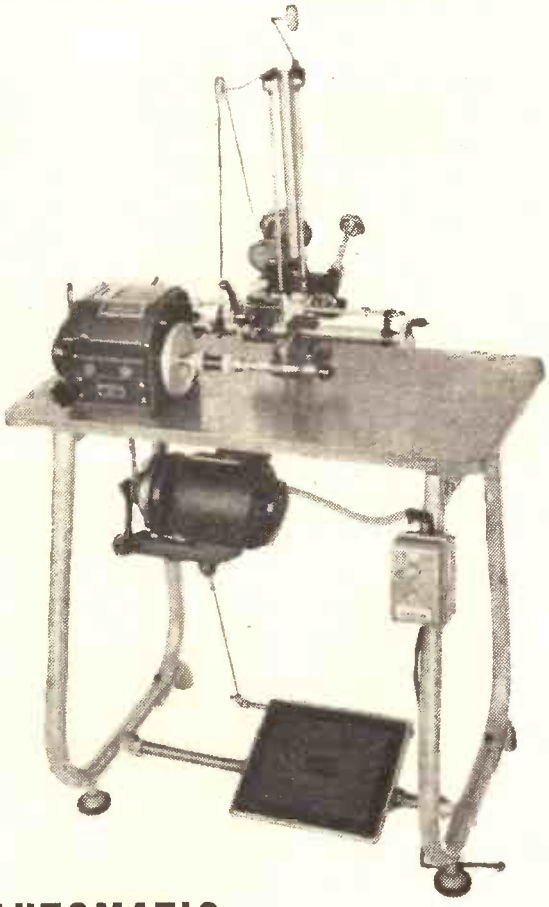

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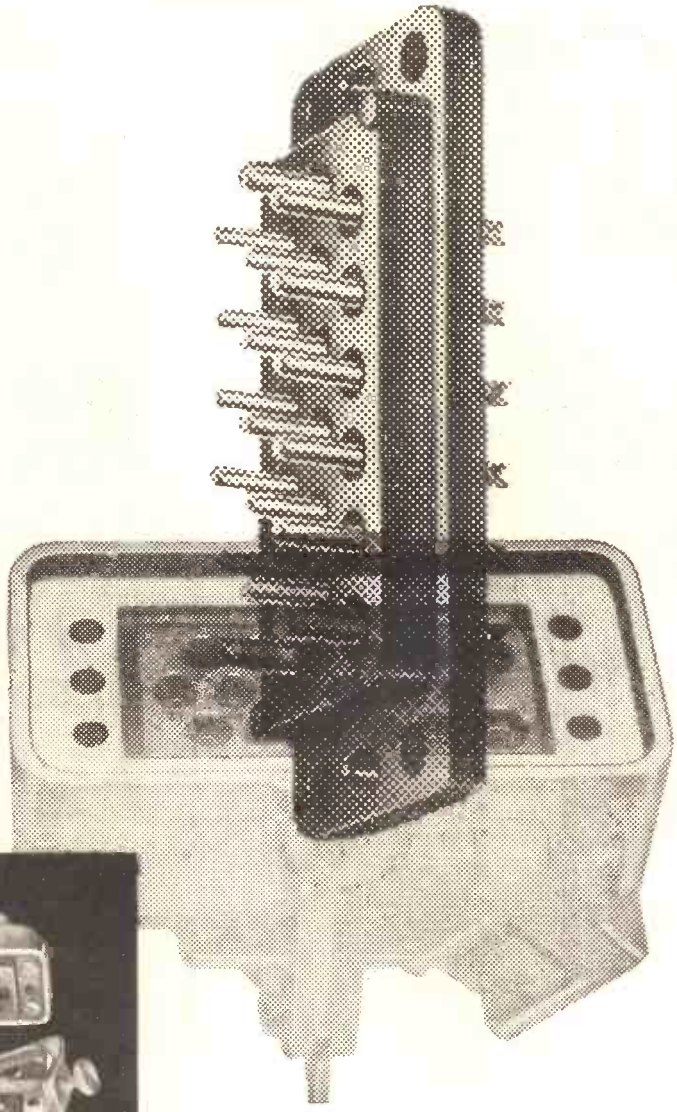

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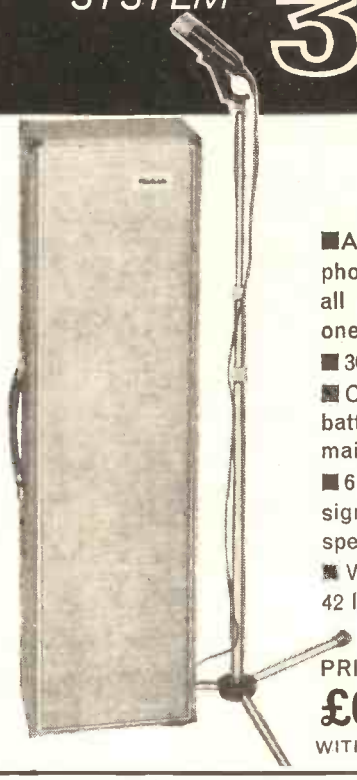

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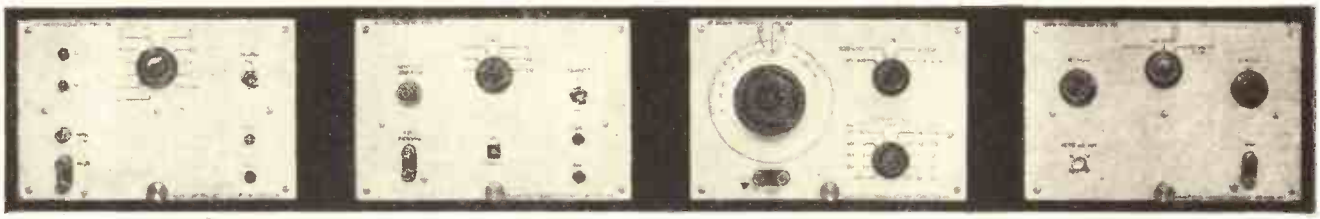

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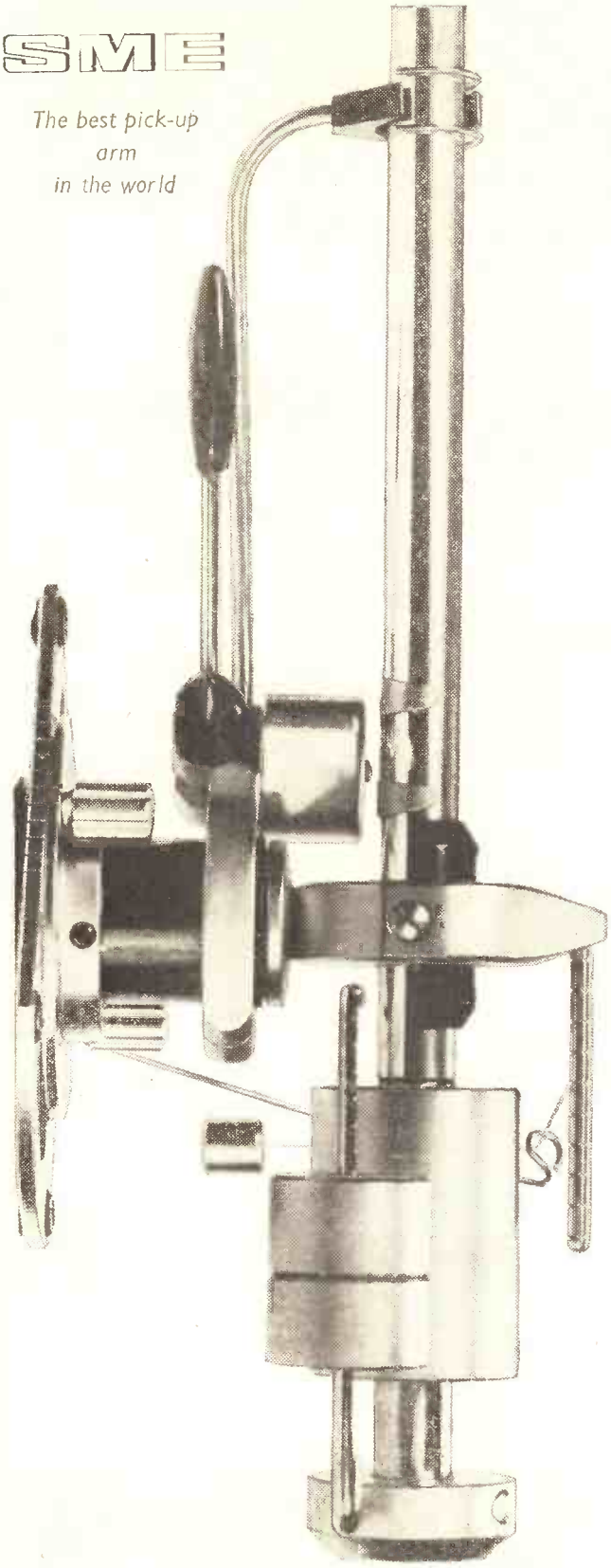

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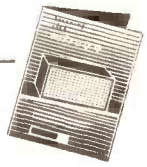

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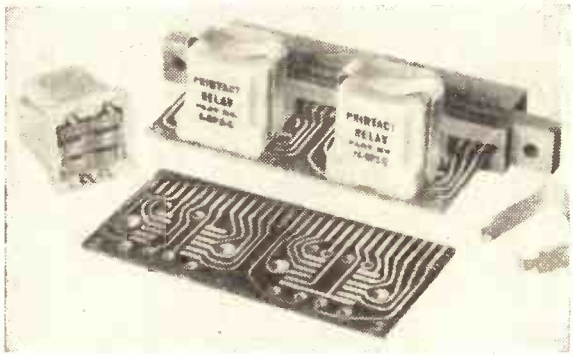
4WW—053 FOR FURTHER DETAILS.

THE MIGHTY MIDGET

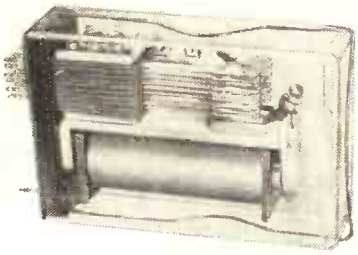
Printed Circuit Relay

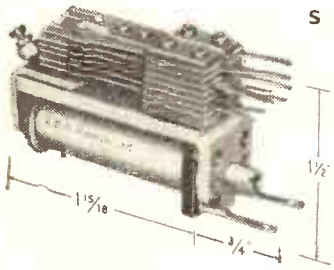


Supplied as standard or latching type, single or double winding. Size $\frac{7}{8}$in. cube, weight 0.8 oz.
Contact Rating 24 v. D.C. 3 pole double throw.
Voltage: 6, 12, 24, v. D.C. Power: 500 mW. Speed 10mS.
Temperature: 70 C max.

3000 TYPE PLUG-IN

Size 4in. x $2\frac{7}{8}$in. x $1\frac{1}{4}$in. Specification as 3000 type 6 change overs maximum, light duty.





S 1500 MINIATURES

A.C. or D.C. operating. Coil up to 10,000 ohms. Single or double winding. Contact material — Silver, Platinum, Spring Set — 6 change overs. Light duty maximum. Size: 2 11/16in. x $1\frac{1}{2}$in. x $\frac{3}{8}$in.

We are manufacturers of full ranges of 3,000 type, 600 type, and plug in relays, also 12 way mounting rack 19in. x $3\frac{1}{4}$in. Further details available on request to Mr. Clemens.

FULLY APPROVED HOUSE
7 DAY PROTOTYPE SERVICE

A.D.S. RELAYS Ltd.

89-97, ST. JOHN STREET, LONDON, E.C.1.
Telephone: CLErkenwell 3393

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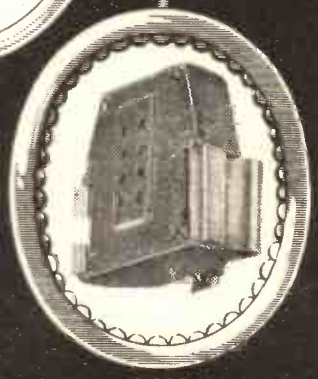
A 301



A 303

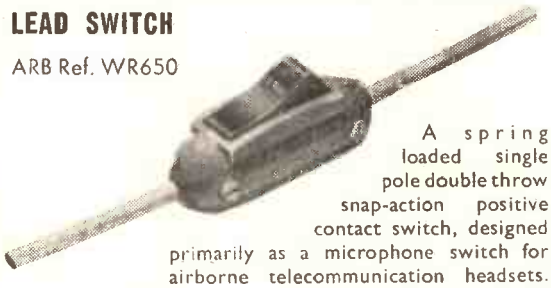
MINIATURES from Airmed Ltd

Rugged high performance carbon microphones for communication use. They can be mounted on headset booms where small size and weight are obvious advantages. Both types can also be mounted in various ways to meet individual requirements.
These microphones are designed for close speaking where the special acoustic screens, high electrical output and tailored frequency response make an important advance in speech transmission.

SPECIFICATION	A 301	A 303
Frequency response	200-5000 c/s	200-4000 c/s
Sensitivity	—50dB/V/dyne/cm² at 1000 c/s	
Load Resistance	100 to 250 ohms	100 to 250 ohms
Feed Current	Approx. 40 mA	60 to 85 mA s/c current
Mounting	By two 8 BA screws which also form the contacts.	Special slip contact for mounting on headset boom.
Finish	High impact injection moulded case. Hermetically sealed except for small equalising leak. Fully tropicalised.	

LEAD SWITCH

ARB Ref. WR650



A spring loaded single pole double throw snap-action positive contact switch, designed primarily as a microphone switch for airborne telecommunication headsets.

RATINGS: D.C. 28 v. D.C. max. at 100 mA.
A.C. 240 v. A.C. at 2 A.

Airmed LIMITED
EDINBURGH WAY
HARLOW · ESSEX
TEL: HARLOW 24331
One of the Clement Clarke Group

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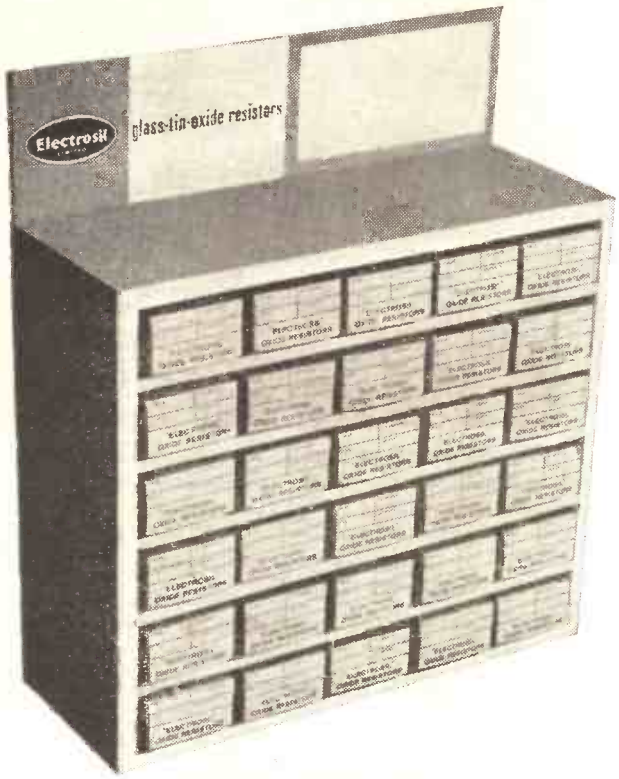
electrosil have the resistor kit that every laboratory needs



one small cabinet gives you semi-precision, high stability, general purpose—because each Electrosil resistor does three jobs

The exclusive Electrosil triple-rating concept now gives you a compact metal oxide resistor kit which will be of the utmost use in every electronics laboratory and experimental unit. Thirty values of resistor gives a choice of three operational modes in each value. The normal cabinet covers the E6 range of preferred values, but special combinations of resistance values can be supplied to order.

Now you can build Electrosil reliability into your designs right from the start, with the resistors you need where you want them, when you want them.

cut out the 'bits and pieces' and get the resistor situation under control

- ☐ The Electrosil Laboratory Kit gives many advantages:—Immediate availability of the best metal oxide film resistors currently available.
- ☐ A compact stock because each resistor has three ratings making it suitable for semi–precision, high stability or general purpose applications.
- ☐ Advantageous prices.
- ☐ Savings in time and effort in stores requisitions and searching for required types and values.
- ☐ Ease of stock replenishment—just use the re-order card.
- ☐ A permanent solidly constructed cabinet which is either free-standing or wall-mounted as required.

Electrosil LIMITED

ELECTROSIL LIMITED

PALLION SUNDERLAND, CO. DURHAM

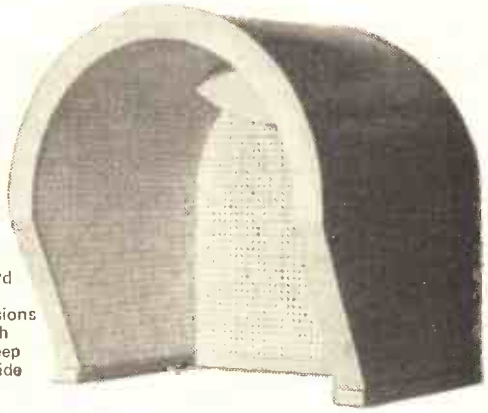
Tel: Sunderland 71557 Telex 53273

4WW—056 FOR FURTHER DETAILS.

WHITELEY

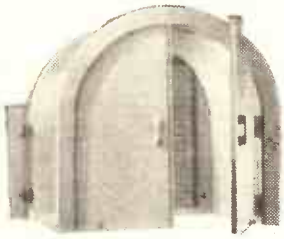
for acoustic hoods

All noisy environments such as factories, workshops, department stores and hotels require the facility of an acoustic hood which permits telephone conversations to be held without the interference of annoying background noises. Whiteley acoustic hoods are strongly made from resin bonded ply and finished in a cellulose enamel which makes these suitable for indoor or outdoor use.



Standard Hood Dimensions
25" high
20¼" deep
24½" wide

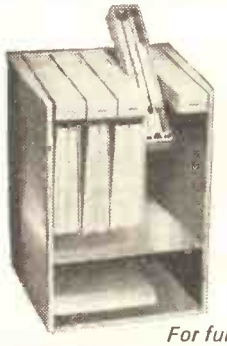
Fitted with loudspeakers



Fitted with doors for outdoor use

Also available with internal light and/or a storage shelf below hood

& directory holders



These attractive, and extremely functional directory holders will hold five directories neatly and securely, in individual swivel holders permitting easy identification and reference. The lower shelf provides additional storage space. The units are of cast alloy and are finished in an attractive grey epoxy resin enamel and constructed to strict G.P.O. design specifications.

Directory Holder Dimensions
17¼" high x 13½" wide x 13⅝" deep

For further details please write or telephone.

WHITELEY ELECTRICAL RADIO CO. LTD
Mansfield · Notts. Telephone: Mansfield 1762-5

4WW—057 FOR FURTHER DETAILS. WB178

It costs less to find the answers

WITH THIS NEW LABORATORY RESEARCH TOOL

The LABCORDER

Instrumentation recording for research or laboratory use has usually meant costly, bulky equipment. *NOW,* the moderately priced EPSYLON MR800 'LABCORDER' provides all the facilities you will require in a compact, easily portable form—with simple operation and attractive savings in cost.

The 'LABCORDER' is suitable for many industrial data recording applications. Here are a few distinctive features

- *Two Wide Band FM Channels*
- *Speech Channel*
- *Time Marker Channel*
- *Four Tape Speeds allowing 8:1 expansion or compression of Data Time Scales*
- *Precise Tape Speed Control*
- *Quarter inch Magnetic Tape*

For digital recording, an alternative model, the MR800D is available. Features include four digital channels and high packing density.

Please write or telephone for descriptive literature.

EPSYLON LABCORDER

EPSYLON INDUSTRIES LIMITED
Faggs Road, Feltham, Middlesex, England.
Telephone: FELtham 5091/5

STONE PLATT GROUP

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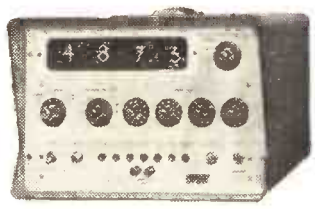
In one of the largest steel-rolling plants in Europe the problem of measuring thickness variations between 0.5% and 2% at strip speeds of 100 to 2,000 ft/min has been overcome. Normal thickness-gauge accuracy of about 1% was inadequate. The problem was solved by the employment of Racal digital instrumentation. This equipment measures the ratio of the outgoing and incoming steel strip velocities and presents the thickness variation on a digital read-out to an accuracy of 0.1%. Provision is made in the system to compensate for differing diameters of the deflector rolls. Simultaneous analogue and digital recording of the information can be provided.



SA.501A A FERRITE-CORE COUNTER DESIGNED FOR THE INDUSTRIAL ENVIRONMENT FOR PRECISION SPEED AND RATIO MEASUREMENT

STEEL IS WHERE
RACAL COUNTS

RACAL

RACAL INSTRUMENTS LIMITED
Dukes Ride, Crowthorne, Berkshire
Telephone Crowthorne 2272/3 and 3763
Grams/Cables: Bracknell Telex 84166

R1/A72

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Magnoval/Novar

McMurdo make valveholders for Magnoval based valves with 0.05″ diam. pins and Novar based valves with 0.04″ pins both types on same pitch circle. Available for printed circuit or chassis mounting. The Novar valveholders are moulded in red to avoid confusion.

Contact Assembly
Vibrating drum guides contacts into feed line to the automatic press

McMurdo

McMurdo Instrument Co. Ltd.
Rodney Rd., Portsmouth, Hants.
Tel. Portsmouth 35555. Telex 8612.
Contact our Sales Office for details of our full range
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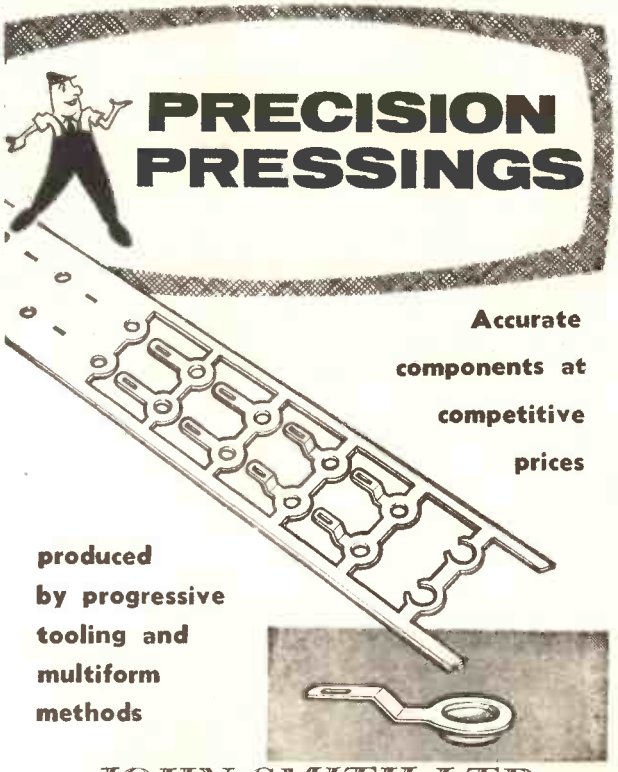

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209 SPON LANE · WEST BROMWICH · STAFFS. TELEPHONE WES 2516
"MITRE MILLS" RICHARD STREET · BIRMINGHAM 7
TELEPHONE ASTon Cross 2218 (4 lines)
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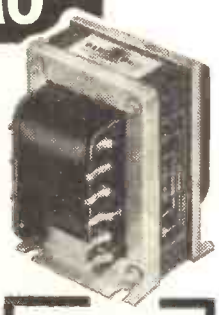
NEW *Partridge* TRANSFORMERS



for use with the

MULLARD 10 + 10 STEREO AMPLIFIER

using ECL 86 Valves

The range of Partridge Transformers for the High Fidelity enthusiast has recently been extended by two new types, for use with the Mullard 10 + 10 Stereo; Output Transformer TG 1073 (price 62/6) and Mains Transformer TG 1074 (price 70/-).

ASK FOR TECHNICAL DATA SHEET No. 41

- *FROM STOCK AND PARTRIDGE SUPPLIERS*

PARTRIDGE TRANSFORMERS LTD.

ROEBUCK ROAD, CHESSINGTON, SURREY. *Telephone: LOWer Hook 4353/4/5*

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MINIATURE IRON (Half Size)

Vari-Stat

THERMOSTATIC SOLDERING IRON

FOR CONTROLLED TEMPERATURE

Miniature Model 50 watt

Weight	1¾ oz.
Heating time	20 secs.
"Push-in" Bit Sizes	3/32", 1/16", 1/32"
Voltage	250 to 12 volts
Price	**55/-**

Instrument Model 70 watt

Weight	4½ oz.
Heating	1½ min.
Bit Size	11/64" dia.
Voltage	250 to 24 volts
Price	Mk.I (Micro-switch) **79/6**
	Mk. II (Magnetic Contact Breaker) **72/-**

Both Models give excellent bit and element life since the thermostat completely eliminates overheating and controls the reserve heating capacity, which makes possible continuous soldering without chilling of the bit.
The consistent temperature makes these irons ideal for printed circuit work.

CARDROSS ENGINEERING CO., LTD.

Woodyard Road, Dumbarton

Phone: Dumbarton 2655

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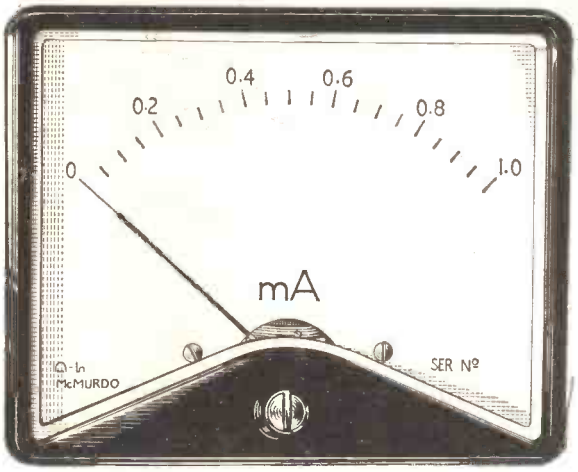
McMURDO MAKE METERS



- MICROAM**METERS**
- MILLIAM**METERS**
- AM**METERS**
- VOLT**METERS**

This is a range of moving coil instruments to B.S.89 for panel mounting. They are supplied in four different case sizes: 3", 2¼" and 1¾" rectangular and 2½" round. For full details of these meters, write to the address below for our illustrated brochure.

McMURDO

McMurdo Instrument Company Limited
Rodney Road, Fratton Trading Estate, Portsmouth, Hants.
Tel: Portsmouth 35555 Telex 8612

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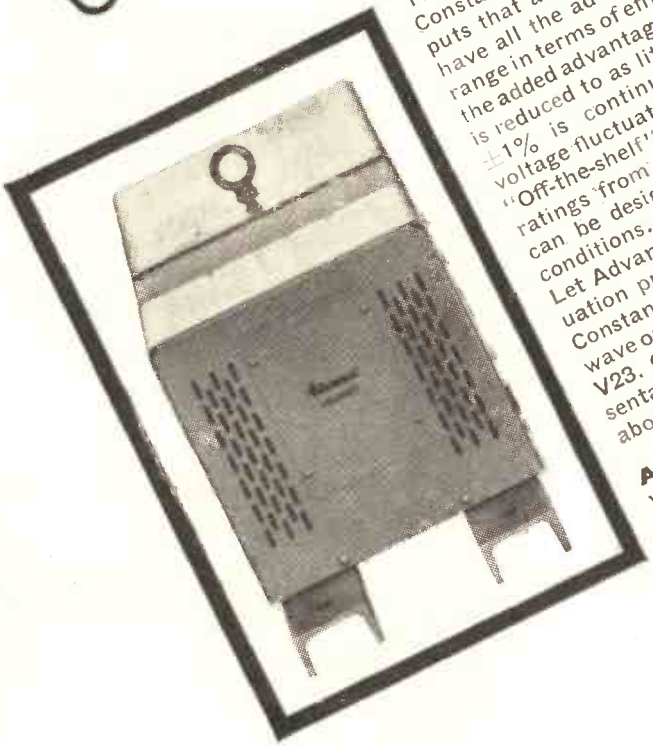
A RANGE OF CONSTANT VOLTAGE TRANSFORMERS

WITH SINE WAVE OUTPUTS

The ADVANCE CVN and CVS range of Volstat Constant Voltage Transformers provides outputs that are substantially sinusoidal. These have all the advantages of the standard CV range in terms of efficiency and response with the added advantage that harmonic distortion is reduced to as little as 3%. Stabilisation to ±1% is continuous and automatic from voltage fluctuations of up to ±15%.

"Off-the-shelf" models are available in power ratings from 75 to 6,000W; special models can be designed to meet a wide variety of conditions.

Let Advance smooth out your voltage fluctuation problems. For full details of Volstat Constant Voltage Transformers with sine wave outputs write for ADVANCE publication V23. Or call up one of our Technical Representatives who will be pleased to tell you about our special design facilities.



ADVANCE ELECTRONICS LIMITED

VOLSTAT DIVISION

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TELEPHONE: HAINAULT 4444

Advance

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JACKSON

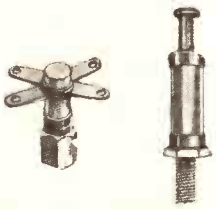
THE BIG NAME IN PRECISION COMPONENTS

Precision built radio components are an important contribution to the radio and communications industry. Be sure of the best and buy Jackson Precision Built Components.

"ADUP" TERMINAL STRIP

These strips, made in units of 3, 4, 5, 6, 7 or 8 can be combined to form assemblies of any length. Special concealed movable bolts enable them to be butted close together without gaps and without irregularities in tag spacing.

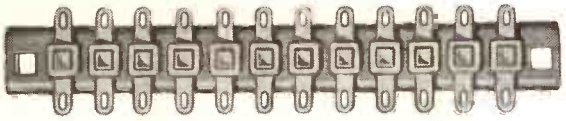
- ★ Strip width 0.5 in.
- ★ Tag spacing 0.25 in.
- ★ Working voltage 1.5 kV.
- ★ Insulation resistance over 20 million megohms.
- ★ Test pull 10 lb.
- ★ Capacitance to base 0.5 pF.



STAND-OFF INSULATORS

Jackson stand-off insulators are designed to perform well in rigorous environments. Their insulation resistance exceeds 20 million megohms even when atmospheric humidity is high. (They meet British Services test specification DEF5334.) They will withstand high steady voltages and intense r.f. fields. Forty different types: ask for catalogue.

- ★ Working voltages up to 10 kV.
- ★ Stoved-on silicone treatment: water repellent.
- ★ Ceramic bodies.
- ★ Silver-plated tags.
- ★ No solder. No plastic. No adhesives.



TERMINAL STRIPS

Jackson terminal strips are assembled without the use of solder, plastics, or adhesives: this guards against breakdown in strong r.f. fields. They are moisture proofed, mechanically strong, and easily fixed.

- ★ Working voltage 1.5 kV. Proof test 5 kV.
- ★ Test pull 10 lb.
- ★ Siliconed ceramic insulation.
- ★ Insulation resistance over 20 million megohms.
- ★ Meet DEF5334 for Services' applications.
- ★ Silver-plated tags, cadmium-plated base.

It's reliable if it's made by Jackson!

JACKSON BROS. (LONDON) LTD

DEPT. W.W., KINGSWAY-WADDON, CROYDON SURREY

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Wireless World

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SI PREGA DI COMPILARE LE SCHEDE A STAMPATELLO

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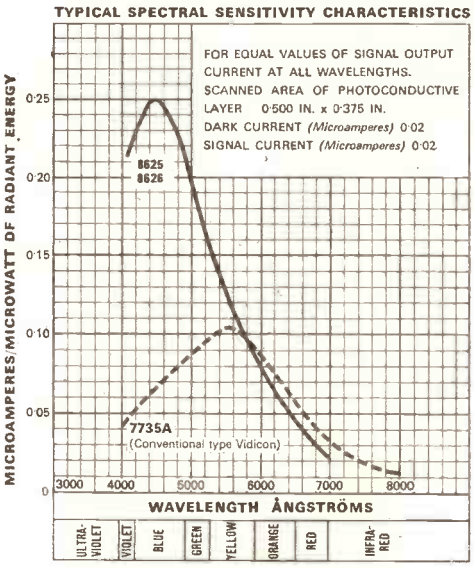

ENGLISH ELECTRIC

ENGLISH ELECTRIC VALVE CO., LTD., can now supply from stock new high sensitivity vidicons which represent an important development in television camera tubes.

These new separate mesh tubes are characterised by their high sensitivity, short lag and high resolution. The spectral response peaks in the blue to provide correct panchromatic reproduction when used with tungsten lighting yet the sensitivity is equal to that attainable with "red sensitive" types such as the 7735A. Although primarily intended for broadcast television these tubes have many industrial applications especially where fluorescent lighting is employed. Two types are available, differing in heater ratings.

8625 with 6.3V/0.6A heater.
8626 with 6.3V/0.095A heater.

Please write for comprehensive data on these and other EEV vidicons.

ENGLISH ELECTRIC VALVE CO LTD CHELMSFORD ENGLAND

Telephone: Chelmsford 3491, Ex 262, Telex 99103 | AGENTS THROUGHOUT THE WORLD

EEV

AP237A

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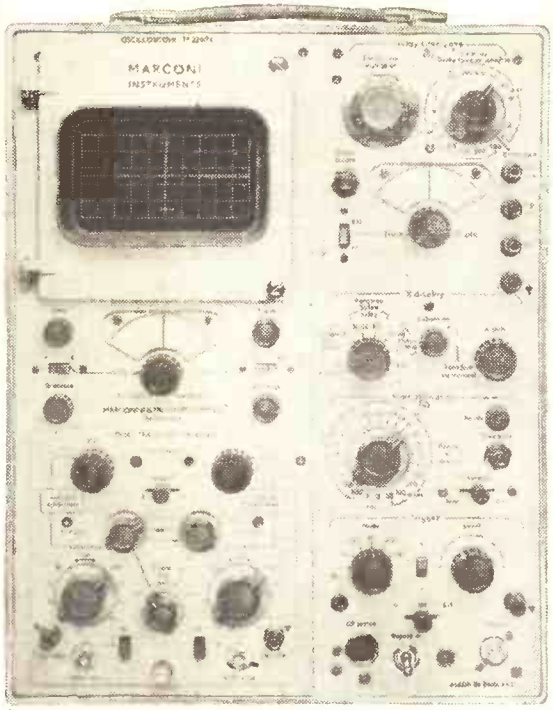
MARCONI INSTRUMENTS LABORATORY MEASURING OSCILLOSCOPE

Type TF 2200A



MORE

versatile

new delaying time base circuitry provides *eighteen* ranges in 1-2-5 sequence, 10 μsec to 5 sec.

MORE

adaptable

new rectangular bezel accepts a wide range of cameras, alternative graticules and viewing aids:
new BNC connectors for Y-input suit all new accessories.

MORE

accessories

new passive and active probes, new graticule projector, new polarising filter, new instrument trolly.

BRIEF SPECIFICATION

* D.C. to 40 Mc/s bandwidth at 50 mV/cm
* 12 nsec rise time for less than 1% overshoot
* 10 nsec/cm writing speed
* 3 mode sweep delay from less than 1 μsec to 5 sec for detailed waveform analysis or line strobe
* Two position frequency roll-off
* Simplified triggering control
* Single-trace, dual trace and TV-differential plug-ins
* Slide-back or direct time and voltage measurement with built in voltage calibration

Are you kept fully informed about Marconi Instruments activities in the oscilloscope field? Continuous development of proven designs (including important valve and circuit improvements in the TF 2200A) is backed by specialised research aimed at the production of radical new instruments and better accessories. Some of the oscilloscope accessories represent significant advances in themselves: an attenuator probe incorporating a X10/X1 switching facility with a cable that is super-flexible and practically unbreakable: a graticule projector which eliminates parallax error, accepts all kinds of standard and specially drawn graticules or reference waveforms, and can be viewed by several observers simultaneously: and a new polarising filter which prevents surface reflection from the face of a tube or graticule.
If you use oscilloscopes please ask to be put on our mailing list for *regular* technical information—starting with full particulars of the TF 2200A.

A GOOD NAME FOR GOOD MEASURE

MARCONI INSTRUMENTS

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TC 280

NOW! A Helipot® for the Laboratory

saves time in experimental circuits

Based on the successful Model T-10-A, the new Beckman HELIPOT Model LP-10 Precision Laboratory Potentiometer sets the same high standards, yet is priced lower.

For experimental applications, where temporary circuits are frequently altered or rebuilt, the LP-10 can be quickly set to a known resistance and positively locked, in one-fifth of the time required by a five-dial decade box.

Utilising a Series A ten-turn HELIPOT precision potentiometer and matching DUODIAL turns-counting dial, the LP-10 provides high resolution with extremely fine resistance and linearity tolerances.

Write for Data Sheet P.10

Beckman Helipot LP-10 precision laboratory potentiometer

® *Registered Trademark*

Beckman® INSTRUMENTS LIMITED
GLENROTHES FIFE SCOTLAND

Fullerton, U.S.A. Geneva Munich Paris Cape Town Tokyo

4WW—068 FOR FURTHER DETAILS. BO-11A

NEW FROM Grampian

CARDIOID MICROPHONE!

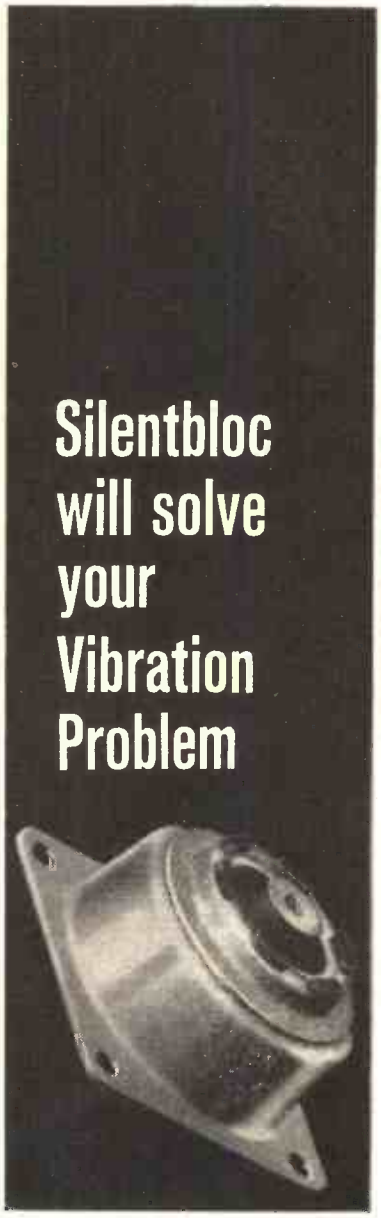
After years of research, Grampian proudly present a microphone with a really good frequency response, high sensitivity and a genuine cardioid pick-up pattern.
More—it is rugged enough to withstand hard usage—and is still in the medium price range. Especially useful under difficult conditions, the Grampian Cardioid is fully up to the highest Grampian standards of workmanship, reliability and *integrity*.
Frequency response 40 c/s to 12 kc/s. Available in 4 impedances: Low impedance £14; other impedances £15. Obtainable *now* from your Grampian dealer. Fullest details from

GRAMPIAN SOUND EQUIPMENT
INTEGRITY THAT YOU *HEAR*

GRAMPIAN REPRODUCERS LTD
Hanworth Trading Estate, Feltham, Middlesex. Feltham 2657

4WW—069 FOR FURTHER DETAILS.

Silentbloc will solve your Vibration Problem



Take a Frustex instrument mounting . . . like the one featured on the left; or the bonded stud next to it. Perhaps the pedestal flange type in the centre and the ring stud mounting to its right command your interest? What do they all *mean?*
They, and the thousands of other components which SILENTBLOC design and manufacture, *mean* the end to most of those vibration troubles.
Combating vibration is SILENTBLOC'S business . . . but we're not dogmatic about it, low-frequencies constitute a special challenge. But, whatever your problem, give it to us — and you can be sure of one thing: if it can be solved we'll find the *correct* answer to it.

ANTI-VIBRATION DEVICES BY

SILENTBLOC

SILENTBLOC LTD · MANOR ROYAL · CRAWLEY · SUSSEX

Telephone: Crawley 27733 *Telegrams: Silentbloc Crawley* *Telex No. 87177*

Andre Rubber Co. Ltd. is another Silentbloc Company *Silentbloc products are also manufactured by Silentbloc (Australia) Pty. Ltd., Melbourne*

4WW—070 FOR FURTHER DETAILS.

Broadway S/503

Measurement of Harmonic Distortion

One of the most essential measurements necessary in a high quality audio system is that of simple harmonic distortion. It is impossible to do serious development work on anything in high quality audio without measurement of this fundamental parameter.

RADFORD make the most advanced audio equipment in the world, and in order to do this it was found necessary to develop measuring instruments of a superior performance than those existing. The Low Distortion Oscillator and Distortion Measuring Set were designed by audio engineers knowing the requirements of such apparatus in audio engineering.

The Low Distortion Oscillator generates sine waves of extreme purity from 5 c/s to 250 Kc/s. The instrument also contains a valve millivoltmeter, a squareing circuit which will produce a clean 250 Kc/s square wave, and a switched 'T' 110 dB 600 ohm attenuator with facilities for continuous interpolation. The distortion of the oscillator is less than 0.005% at mid-band frequencies from its 600 ohm output attenuator. It is also capable of a very low distortion output of about 0.001% or below from the 10K ohm output position at mid-band frequencies.

The Distortion Measuring Set is a complementary equipment, and is capable of measuring extremely low distortion content. The most sensitive range on the instrument is 0.01% f.s.d. On this range it is possible to get an accurate measurement of 0.002% distortion and an indication of the order of 0.001% distortion.

The design of these instruments is described in leaflets which are available upon request.

Prices: Low Distortion Oscillator. **£95.**
Distortion Measuring Set. **£75.**

RADFORD ELECTRONICS LTD.

Ashton Vale Estate, Bristol, 3. Tel.: 662301/2

4WW—071 FOR FURTHER DETAILS.

MECHANICAL RELAY LATCH FOR P. O. TYPE 3000

This latching device enables the P.O. 3000 type relay to be held in the closed position when the coil is de-energised and until manually released.
Does not impair the versatility of the contact arrangements, nor affect the normal mounting position.

WILL TRIP AND HOLD ON A.C. OR D.C. IMPULSE

Please send for illustrated leaflet.

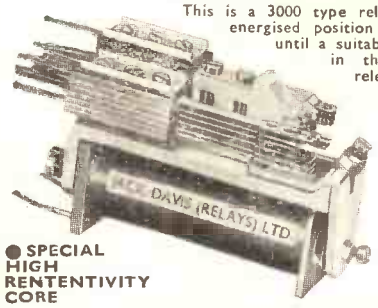
Illustrations show 3000 Type Relay fitted with "Remote" and "Local" release latch.

EITHER TYPE CAN BE FITTED TO YOUR EXISTING 3000 TYPE RELAYS IN A MATTER OF MINUTES

STANDARD 3000 TYPE RELAYS
BUILT TO SPECIFICATION

Quotations by Return of Post. Prototypes within 48 hours.

THE "REMANENCE" RELAY



This is a 3000 type relay capable of latching in the energised position after the supply is removed until a suitable releasing current is applied in the opposite direction. This releasing current is controlled by two methods:—

1. With a single coil, by reducing the operating current in reverse.
2. With a double coil, via a pair of contacts employed on the relay to energise the second coil.

Information on any contact arrangement to be employed can be obtained on application.

● SPECIAL HIGH RENTENTIVITY CORE

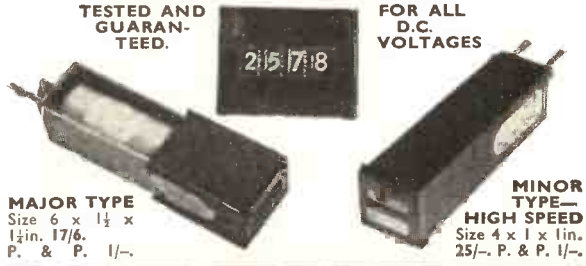
Ministry of Aviation Approved Inspection **EID**

● RELAYS Type 600 ● Polarised ● AC Relays ● High Speed ● Uniselectors ● Latching Relays ● Magnetic Counters ● Miniature Sealed Relays. Available from stock or supplied to specification.

ELECTRO-MAGNETIC COUNTERS

TESTED AND GUARANTEED.

FOR ALL D.C. VOLTAGES



MAJOR TYPE
Size 6 x 1½ x 1½in. 17/6.
P. & P. 1/-.

MINOR TYPE—HIGH SPEED
Size 4 x 1 x 1in.
25/-. P. & P. 1/-.

Jack Davis (Relays) Ltd.

Dept. "W," 9/10, MALLOW STREET, OLD STREET, LONDON, E.C.1 Tel. CLErkenwell 3661/2

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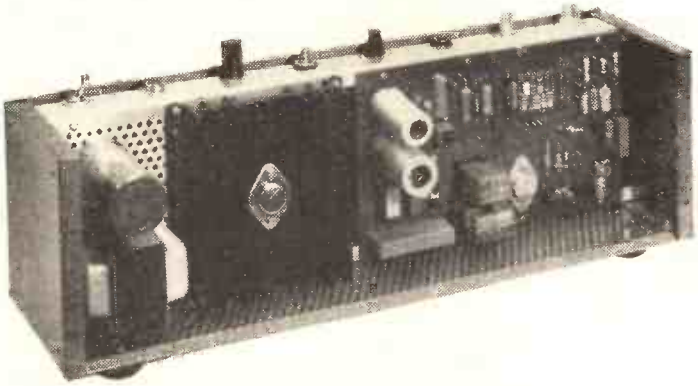
LEKTROKIT

Chassis System



The Lektrokit Construction Systems consist of a limited range of simple and inexpensive components, which can be quickly assembled to form chassis and racks for electronic circuits and equipment. The components are designed for serviceability and ease of assembly; no special skills are called for, and the only essential tool is a screw-driver. The finished assemblies, which may be of any practical size, are suitable both for laboratory and small production purposes, and any assembly may be rearranged or extended during or after construction

Write to A.P.T. for free price list and booklet of the Lektrokit Chassis System.

Name_____

Company_____

Address_____

A·P·T ELECTRONIC INDUSTRIES LIMITED

Chertsey Road, Byfleet, Surrey Phone: Byfleet 41131/2/3/4 PABX Grams: Aptran, Byfleet

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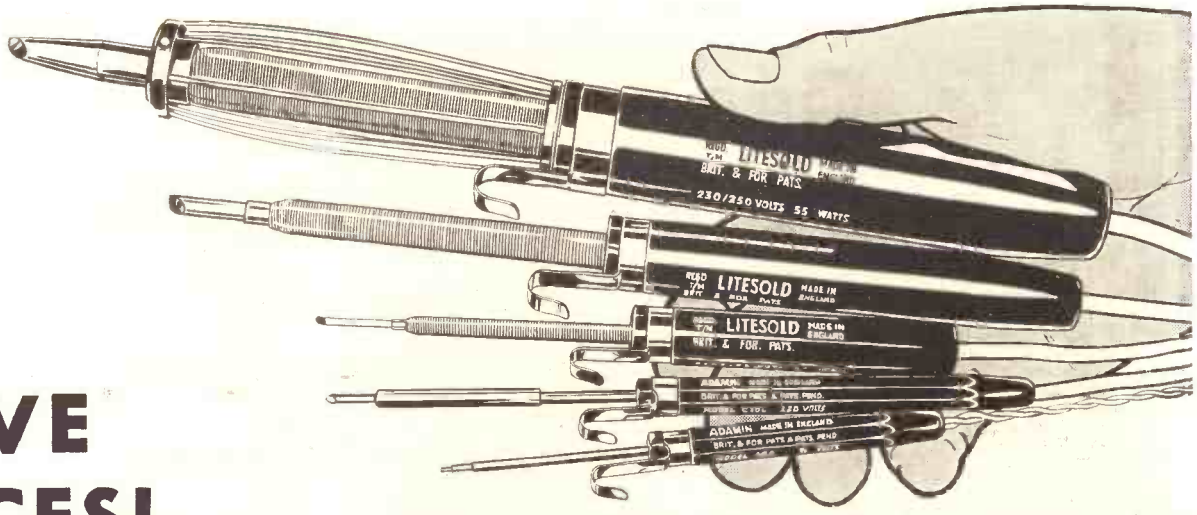

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Brochure W5 post free on request.

LIGHT SOLDERING DEVELOPMENTS LTD., 28, Sydenham Road, Croydon, Surrey.
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WEYRAD

COILS AND I.F. TRANSFORMERS IN LARGE-SCALE PRODUCTION FOR RECEIVER MANUFACTURERS

P.9 SERIES 10 mm. × 10 mm. × 14 mm. Ferrite cores 6 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.

P.55 SERIES 12 mm. × 12 mm. × 20 mm. Ferrite cores 4 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.

T.41 SERIES 25 mm. × 12 mm. × 20 mm. Ferrite cores 4 mm. 472 kc/s operation. Double-tuned 1st and 2nd I.F.s and Single-tuned 3rd I.F. complete with diode and by-pass capacitor.

These ranges are available to manufacturers in versions suitable for most of the popular types of Transistors. The Oscillator coils can be modified to enable specific tuning capacitors to be used provided that bulk quantities are required.

OUR WINDING CAPACITY NOW EXCEEDS 50,000 ITEMS PER WEEK

On the most up-to-date and efficient machines backed by a skilled assembly labour force for all types of coils and assemblies.

Weymouth Radio Manufacturing Co., Ltd., School Street, Weymouth, Dorset

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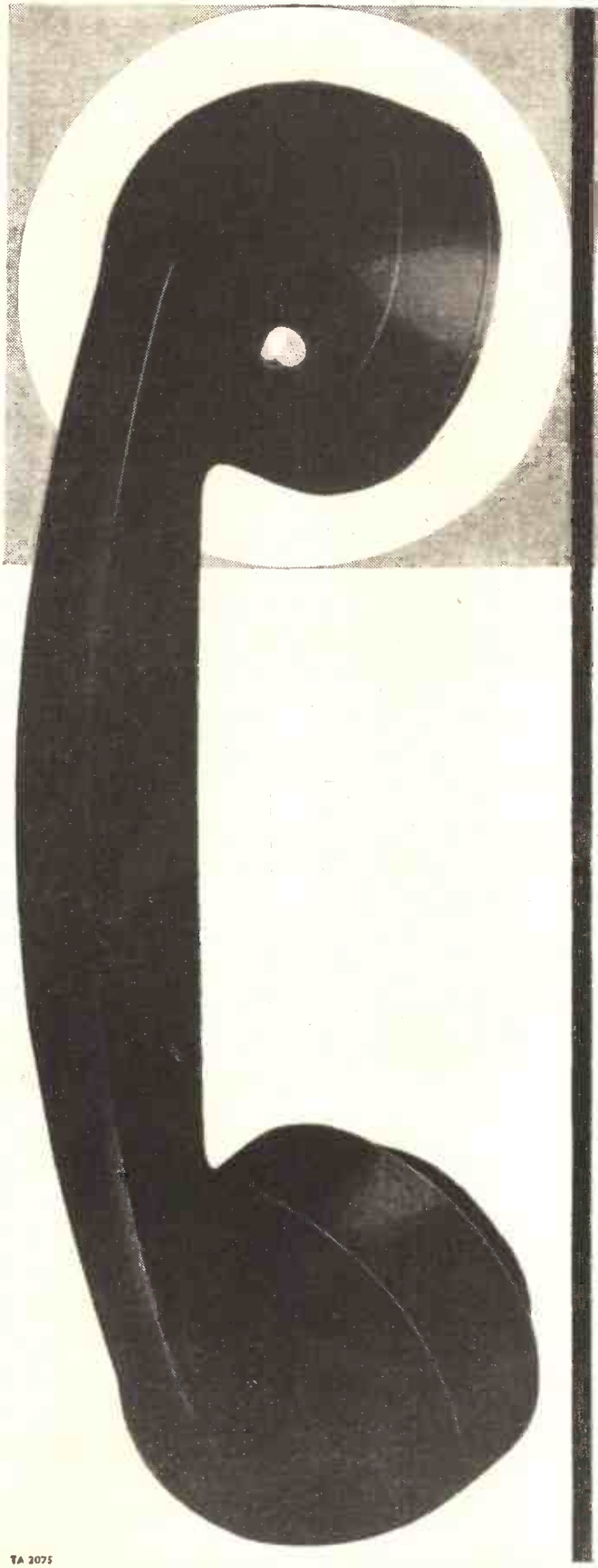

new lightweight

B.P.O. APPROVED

push-button handset

TYPICAL USES

* Provides a convenient means of switching on and off to conserve power from local battery.
* Short-circuits transmitter to reduce side tone noise.
* Cuts out conversations when making asides.
* Switches radio transmitter when used for radio telephony.

MICRO-SWITCH CONTROL

A fast-acting changeover speed of 5 milliseconds makes the provision of a make-before-break action unnecessary, since holding relays of automatic exchanges will not release in so short a time. The switch action is easily changed from locking to non-locking.

RECEIVER

High-efficiency electro-dynamic as standard.

OPTIONAL TRANSMITTERS

STANDARD—two carbon electrodes, or HIGH-OUTPUT LOW-DISTORTION—three carbon electrodes, or HIGH EFFICIENCY—electro dynamic.

LIGHT, DURABLE, ATTRACTIVE

Moulded in impact-resistant co-polymer—highly finished in black, light ivory or elephant grey. Basic weight with cord, only 362 gm (12¾ oz).

Made by AEI—specialists for many years in press-key handsets—this versatile instrument meets the need for modern styled handset with push-button facilities. It has been adopted by the British Post Office. A range of five types has been standardised.

Please write for fully descriptive leaflet 5871-81

AEI COMMUNICATIONS

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED
TELEPHONE APPARATUS DEPARTMENT
TELECOMMUNICATIONS DIVISION
Woolwich London SE18 (Woolwich 2020 Ext. 326)

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1 PHASE
AND
3 PHASE

0.5 KVA
TO
250 KVA

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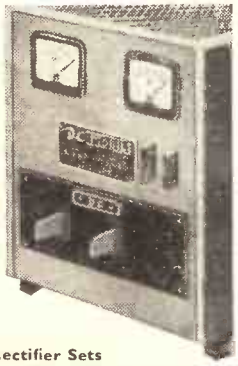
100 W 150 kW
FIXED OR
VARIABLE OUTPUT
1 PHASE & 3 PHASE

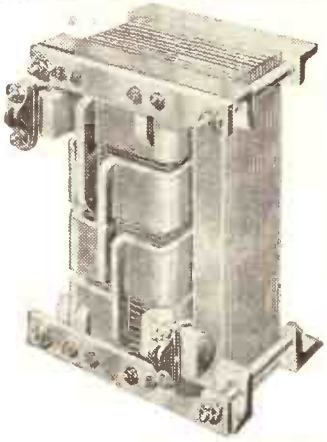
Electro-Plating, Plasma, Arc Welding, Electro-Magnets, Carbon Arc, Battery Charging and other uses.

Plasma Arc Sets and other specialized equipment for gas, vacuum and powder techniques. Power Control by saturable reactors and other methods.

Variable Output
D.C. Sources



Low Voltage High Current Rectifier Sets



HIGH CURRENT TRANSFORMERS

1 Phase and 3 Phase

Output currents of hundreds or thousands of amperes for Furnaces, Rectifier Sets, Heat Runs, Short Circuit Testing and other uses.

Examples: 5V300A.
10V1,000A
20V3,000A
5V6,000 A.

VOLTMOBILE

64 STEPON LOAD SWITCHING AUTO-TRANSFORMERS

Output 1.6% to 100% or 125% of input volts in 64 steps or 80 steps. A control device for many loads — resistance furnaces, rectifier sets, battery charging, anodising, heating and other uses 1 Phase and 3 Phase. 18 Models.

Output currents from 20 A to 200 A.

HARMSWORTH, TOWNLEY & CO.
2 Harehill, Todmorden, Lancs.
Telephone: Todmorden 602

Valradio

TRANSVERTERS

(TRANSISTORISED D.C. CONVERTERS)

the D.C. conversion specialists since 1935

2 KW. Peak Starting. 750 W. Continuous. 50-60-400 c/s. or D.C. from 12-24-50 v. Battery. Up to 93% Efficiency. Polarity Reversal Protection. Square or Sinewave. Up to 300% Instant Overload Capacity. Manually Controlled Frequency. Reed Type Indicator. Remote Control Facilities.

Applications: Static "No-Break" Standby Power Supplies: For Vital System(s) Protection, e.g. V.H.F. Transmitters: Industrial Processes; Control-Alarm-Warning Systems: Mobile Use of Counters; Sig./Gen. Recorders—U/V Sound. Oscilloscopes and Lab. Gear in Marine and Aircraft (K114).

Range of models available with prices from £11-£94.10.0 *Please write to department C.10 for transverter leaflet.*

VALRADIO LIMITED
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Telephone: FELTHAM 4837

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STAND 113, R.E.C.M.F. SHOW
18th—21st MAY

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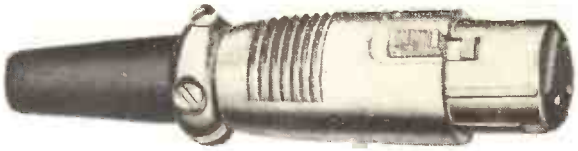
NUMBER ONE IN ELECTRICAL CONNECTORS... 1



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CANNON® PLUGS

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INDUSTRIAL SENSING DEVICES
BY
ELECTRONIC MACHINE CONTROL LIMITED

GLOSSARY OF TERMS

NO.1
CAPACITY

CONTIMITOR Type CON. 1
A capacity operated monitor which provides a continuous indication of level on a meter or recorder. A large number of industrial and laboratory problems can be solved by its use.

PROXITRAN Type PTR. 1
A transistorised level control switch that will sense and control levels of solids, granules, powders or liquids in tanks, bins, hoppers and other similar containers.

PULSIMITOR Type PUL. 1
A capacity operated electronic switch that will give a pulse output against a very small change in input capacity that may be used for counting on conveyors, machine and safety control, vibration detection, bottle size sensing and the like.

MINILIM Type ML. 1
An extremely small unit, similar in principle to the Proximitor and Limitor. It is designed for use where space is at a premium and may be used where control, sensing and indexing is required.

PROXIMITOR Type PRO. 1
A sensitive, reliable and inexpensive capacity operated relay that may be used for counting, level control of liquids and solids, interface between immiscible fluids, safety devices, sensing metal markers in paper, valve float chamber monitoring, etc.

LIMITOR Type LS. 1
A transistorised proximity switch that will sense objects without physical contact that does not rely on magnetic principles for its operation. It can be used for interlock systems, gating mechanisms, positioning, inhibition circuits and control systems.

INCREMITOR Type INC. 1
An incremental capacity meter of extremely high sensitivity with a very small long term drift that can be used for contactless measurement and control of plastic tube extrusion, plastic sheet processing, electrode spacing, proportional control and moisture control measurement.

These are only a few of the devices available from our very wide range which includes devices in the photo-cell and inductive fields which will be dealt with in future advertisements.

Fully descriptive leaflets are available on request and our technical staff are always glad to help with your problems.

ELECTRONIC MACHINE CONTROL LIMITED
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THE LINEAR 'SUPER 30' HIGH FIDELITY PUBLIC ADDRESS AMPLIFIER

TECHNICAL DETAILS:

SENSITIVITY FOR 30 WATTS
Gram.—50 millivolts.
Mic. 1. 5 millivolts.
Mic. 2. 150 Microvolts.

FREQUENCY RESPONSE
± 2 dB 30 c.p.s.—20,000 c.p.s.

BASS CONTROL
+ 15 dB to — 15 dB at 50 c.p.s.

TREBLE CONTROL
+ 12 dB to — 12 dB at 10 Kcs.

HUM AND NOISE
— 60 dB

HARMONIC DISTORTION
0.5% for 30 watts.

VALVES
Mullard ECC83, ECC83, ECC83, EL34, EL34, GZ34.

NEGATIVE FEEDBACK
20 dB

DAMPING FACTOR
12

RETAIL PRICE **33 Gns.**

Send S.A.E. for leaflet.

For operation on standard 200-250 v. 50 c.p.s. A.C. mains. 110/120 v. models available for export.

Trade and export enquiries invited.

LINEAR PRODUCTS LTD.
ELECTRON WORKS, ARMLEY, LEEDS.

A HIGHLY EFFICIENT 30 WATT GENERAL PURPOSE PUBLIC ADDRESS UNIT

With input mixing facilities and outputs for 3 - 7·5 - 15 and 330 ohms (100 volt line).

A special feature of the **SUPER 30** is its high degree of stability, ensuring that the longest output leads can be used without fear of the usual troubles associated with instability.

Three high sensitivity standard jack inputs with provision for high and low impedance microphones.

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SLOW MOTION DIALS

Catalogue No. 585
EPICYCLIC DIAL

This full vision dial incorporates an epicyclic, ball-bearing drive mechanism of improved design and giving a reduction ratio of approximately 10 to 1. The movement is smooth and free from backlash. Dial escutcheon measures 6″ long by 4⅛″ wide, finished ripple black. Four lines are provided on the semi-circular scale for individual calibrations, the outer line being marked from 0 to 100 over 180°. Supplied complete with black instrument knob 2⅛″ diameter.

A high grade assembly for precision instrument applications. Gear driven, flywheel-loaded mechanism, with a reduction ratio of 140 to 1, giving smooth, positive control.

Pointer travel is 7″. A circular vernier scale, marked 0 to 100, is read in conjunction with the lowest line on the main scale, which has five lines for individual calibration. Overall dimensions 9¼″ by 5¾″. Diecast escutcheon finished glossy black to match 2⅛″ diameter instrument knob. Complete with fixing screws and mounting template.

Catalogue No. 898
GEAR DRIVEN

Data Sheets from the Manufacturers
STRATTON & CO. LTD.
BIRMINGHAM 31

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The Complete range of "Hatfield" instruments may be seen on Stand No. 469 at the R.E.C.S., Olympia, May 18th—21st, 1965

Specialised instrumentation by...

HATFIELD

UNIVERSAL SIGNALLING TEST SET TYPE S.P.O. 7803
Designed to facilitate testing and alignment of transistorised out-of-band signalling equipment and to enable signalling and telegraph relays to be tested and adjusted. An amplifier is provided so that "end-to-end" measurements of signalling distortion may be made at levels higher than nominal.

PSOPHOMETER TYPE S.P.O. 7525
A portable, self-contained transistorised unit, operating from internal battery or from rackside power supplies. Provided with both Telephone and Broadcast Weighting Networks meeting the latest requirements of C.C.I.T.T. (1961, in the case of the "Broadcast" network) selected by front panel switching without external networks. When these networks are switched out of circuit, the instrument can be used as a voltmeter having a substantially flat frequency response over the range 50 c/s to 20 K/cs.

LOW FREQUENCY SELECTIVE LEVEL METER TYPE S.P.O. 7820
Frequency Range: 30 c/s - 30 Kc/s; Expanded Range 30 c/s - 4 Kc/s; Calibration Accuracy: ± 1% ± 5 c/s. Level Range: + 20 dBm to - 105 dBm. Through and terminated measurements may be made on 600 ohm and 140 ohm circuits, balanced and unbalanced. Harmonic discrimination: 65 dB; Accuracy: ± 0·1 dB within range + 5 dB to -10 dB on meter. ± 0·25 dB within range -10 dB to -15 dB on meter. Attenuator accuracy ± 0·2 dB.

LOW FREQUENCY OSCILLATOR TYPE S.P.O. 7806
Used in conjunction with the Low Frequency Selective Level Meter, automatic tracking is provided over the frequency range 30 c/s - 20 Kc/s. Sending levels are + 1 to - 82 dBm with an accuracy of ± 0·1 dB at 1 Kc/s and 0 dBm at 20°C. The "send level" meter accuracy is ± 0·2 dB at other readings and the 0 - 70 dB attenuator accuracy is ± 0·3 dB. Level/Frequency response is ± 0·2 dB and the error due to temperature changes in the range 0°C - 40°C is ± 0·3 dB. 600 ohm and 140 ohm balanced and unbalanced output impedances are provided. The network may be operated from internal batteries or an external 18 to 26·5 V.D.C. supply.

These specialised instruments are manufactured by us by arrangement with the Transmission Division of G.E.C. (Telecommunications) Limited, Coventry who are responsible for the circuit design.
Enquiries for specialised instruments of any kind are welcome. Ask for a copy of our Catalogue or our Technical Representative will call.

HATFIELD BALUN

HATFIELD INSTRUMENTS LTD.,
Dept. W.W., Burrington Way, Plymouth, Devon.
Phone: Plymouth 72773/4 *Grams: Sigjen Plymouth*

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certainly

MEC Type TS Miniature Toggle Switches □ the smallest switches available, 0.25 inch diameter □ mount 9 to the square inch □ Single-pole change-over with quick make, quick break action □ Mechanical life in excess of 40,000 operations □ Current rating 1A at 50 volts d.c. □ Two models, TS70, silver contacts, 10 milliohms contact resistance, TS71, gold-plated contacts, 6 milliohms contact resistance □ Temperature range 0°C to 85°C □ Prompt delivery □ Send for full details, price list □ Miniature Electronic Components Ltd., St. Johns, Woking, Surrey. Tel. Woking 5211.

m-e-c

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MINISTRY OF AVIATION APPROVED INSPECTION.

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TOROIDAL—'C' CORE—PULSE—MATRIX

CHASSIS—CABINETS & PRECISION METALWORK
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IMPEX SEMICONDUCTORS

Supplies are available of fully tested semiconductors with slightly relaxed specifications. Continuity of supply is always assured. Availability list upon request.

S3IT p-n-p audio frequency transistor similar to OC81 V_{CE} max. = −9V; V_{BE} max. (I_C = 1.5mA) = −200mV; V_{BE}max. (I_C = 300mA) = −750mV; I_{CBO} (V_{CB} = −9V) <25μA; h_{FE} > 100.

S9IT silicon junction transistor similar to OC204 V_{CB} max. = V_{CE}max. = −14V; $I_E$max. = 450mA; I_B max. = 90mA; I_{CO} (V_{CE} = −6V) <0.3μA; fl (V_{CE} = −6V, I_C = 1mA) = 1.5 Mc/s.; h_{FE} > 14.

S3R germanium general purpose point contact diode. P.I.V. 22V.

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You need a

Lexor

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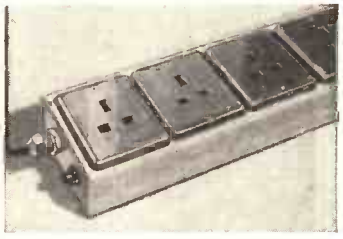

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SHAPES OF SOUND

The Goldring-Lenco GL58

The GL58 has long been popular amongst knowing audiophiles as the only transcription unit that provides true high fidelity quality at a really modest price. Now, in keeping with the modern trend towards shelf and table installations, the GL58 is also available plinth-mounted or with an elegant shallow cabinet with Perspex cover.

GL58 TRANSCRIPTION UNIT. The GL58 incorporates a sturdy, precision-engineered Swiss motor, a continuously variable speed-adjustment system with four adjustable click-in positions for standard speeds, an ingenious groove-selector-cum-lowering-device for the arm, and an integral transcription arm of proven performance which will accommodate any standard-fitting cartridge, on a removable 'platform'. All these features and a surprisingly low price make the GL58 an outstanding buy for hi-fi enthusiasts on a limited budget.

GL 58 TRANSCRIPTION UNIT: £14.14.0 + £2.7.9 P.T.
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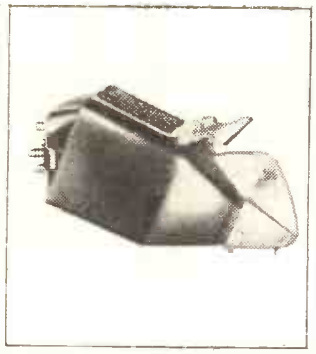
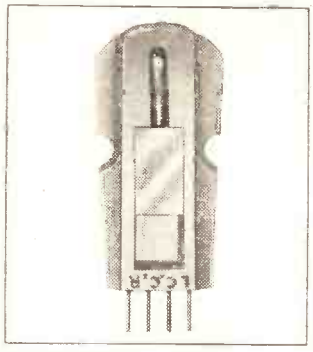
C 58 CABINET AND COVER FOR GL 58 Elegant sapele mahogany cabinet with removable, clear Perspex dust cover. Cut for spring or rigid mounting of unit. Size: 14″ x 17″ x 7″. **£8.19.6** + £1.12.0 P.T.

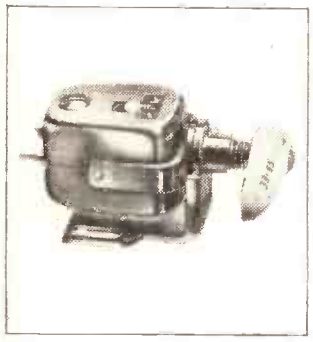
**Recommended cartidges for the GL 58 are: Pickering 380 A, Goldring CS 90 and Goldring 580.*



***PICKERING 380A**
Moving-magnet cartridge for exceptional mono or stereo reproduction. Features the exclusive V-guard push-in diamond stylus unit which prevents damage through accidental dropping of arm on record. The Pickering 380A ensures high channel separation and virtually eliminates needle talk, hiss or distortion. Hermetically sealed, it tracks at 2 grams, faultlessly reproduces the most exacting records. £12.12.0 + £2.0.11 P.T.



***GOLDRING CS 90**
A stereo ceramic cartridge with excellent frequency response and cross-talk separation. Can be played at light tracking weights and gives an output of 50 mV. Fitted with replaceable 0.0005″ tip diamond stylus. £4.4.0 + 13.8 P.T.



***GOLDRING 580**
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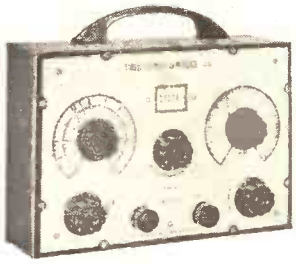

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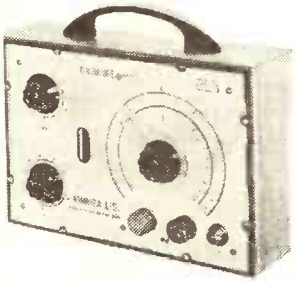

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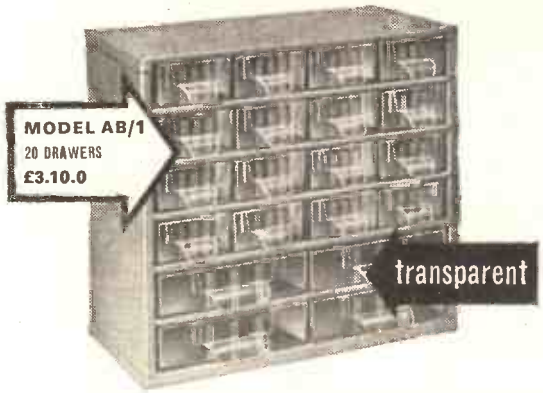

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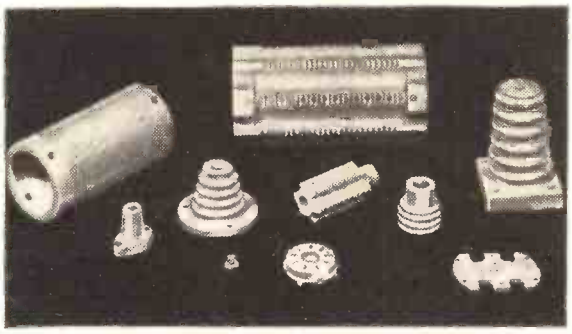

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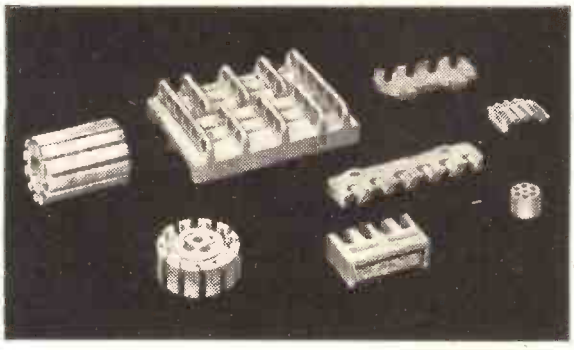

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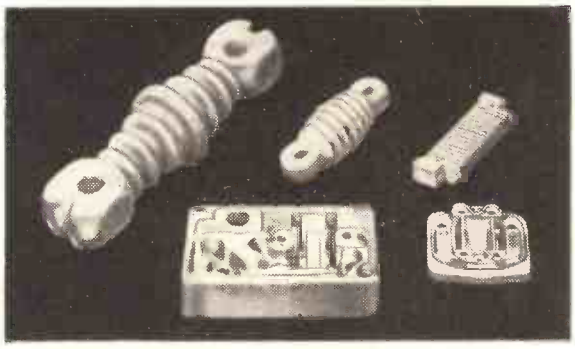

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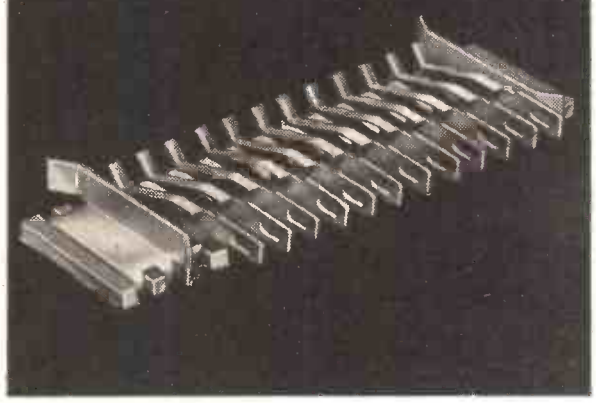

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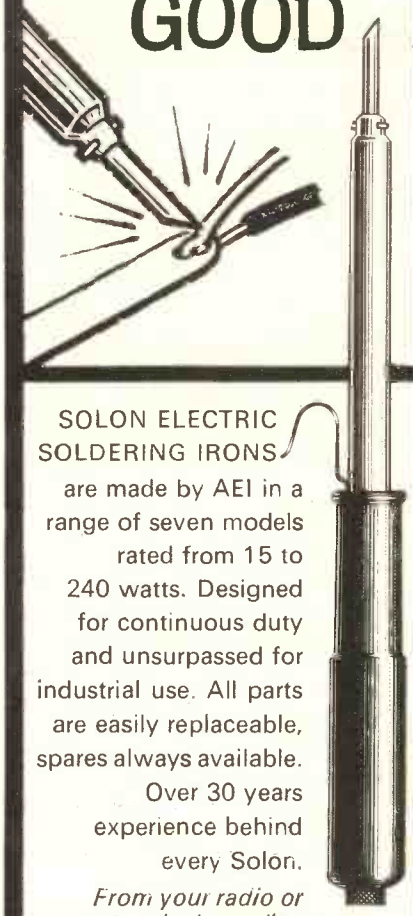

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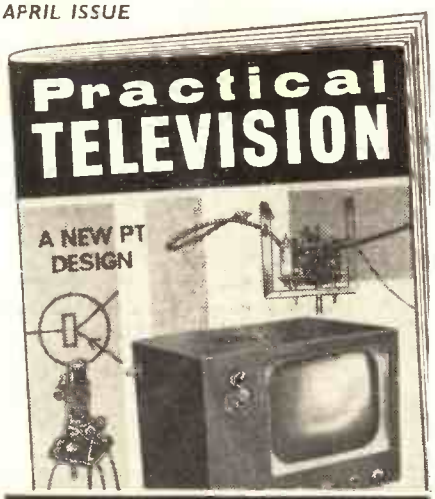

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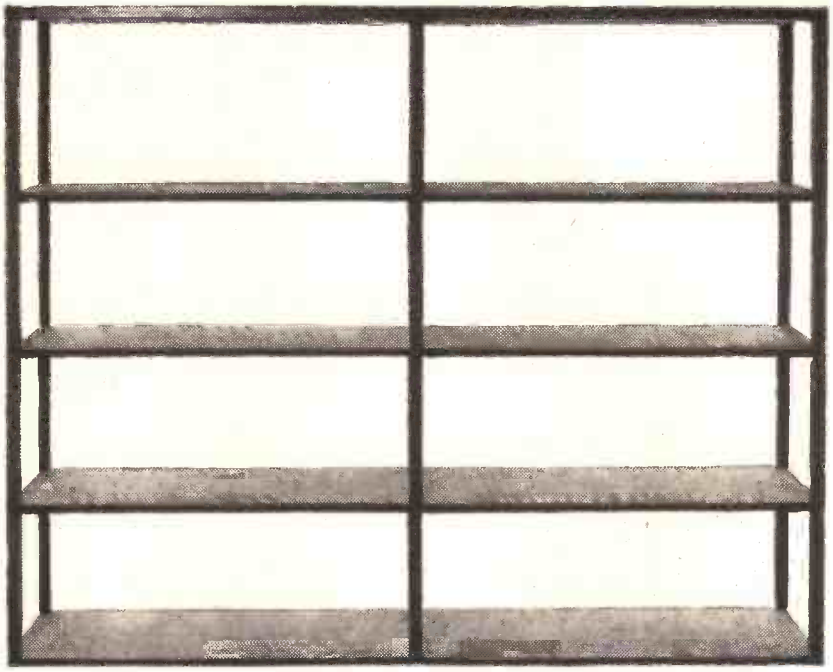

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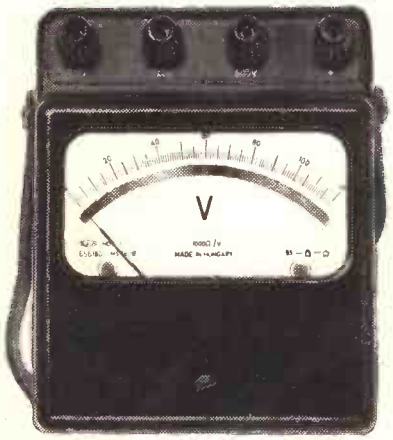

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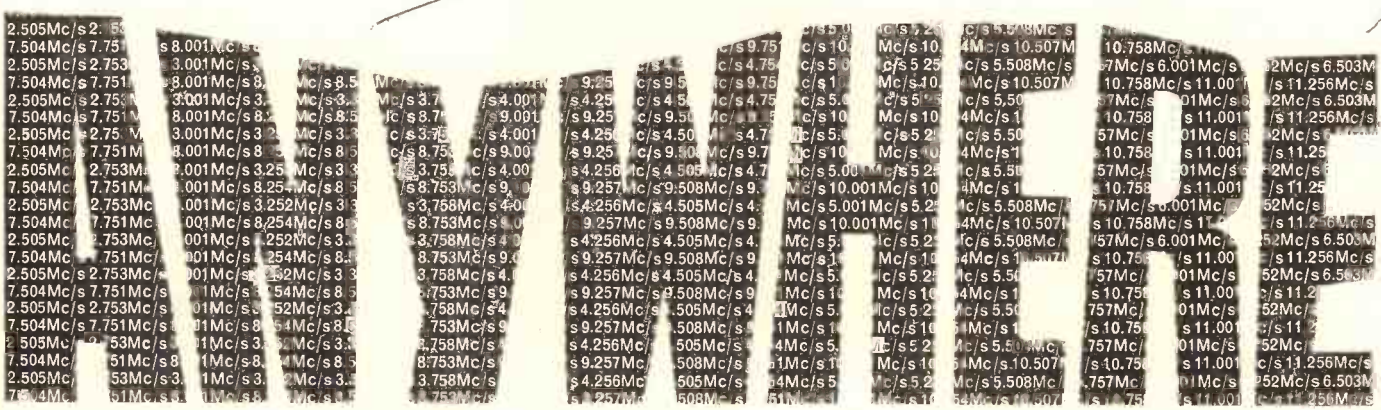

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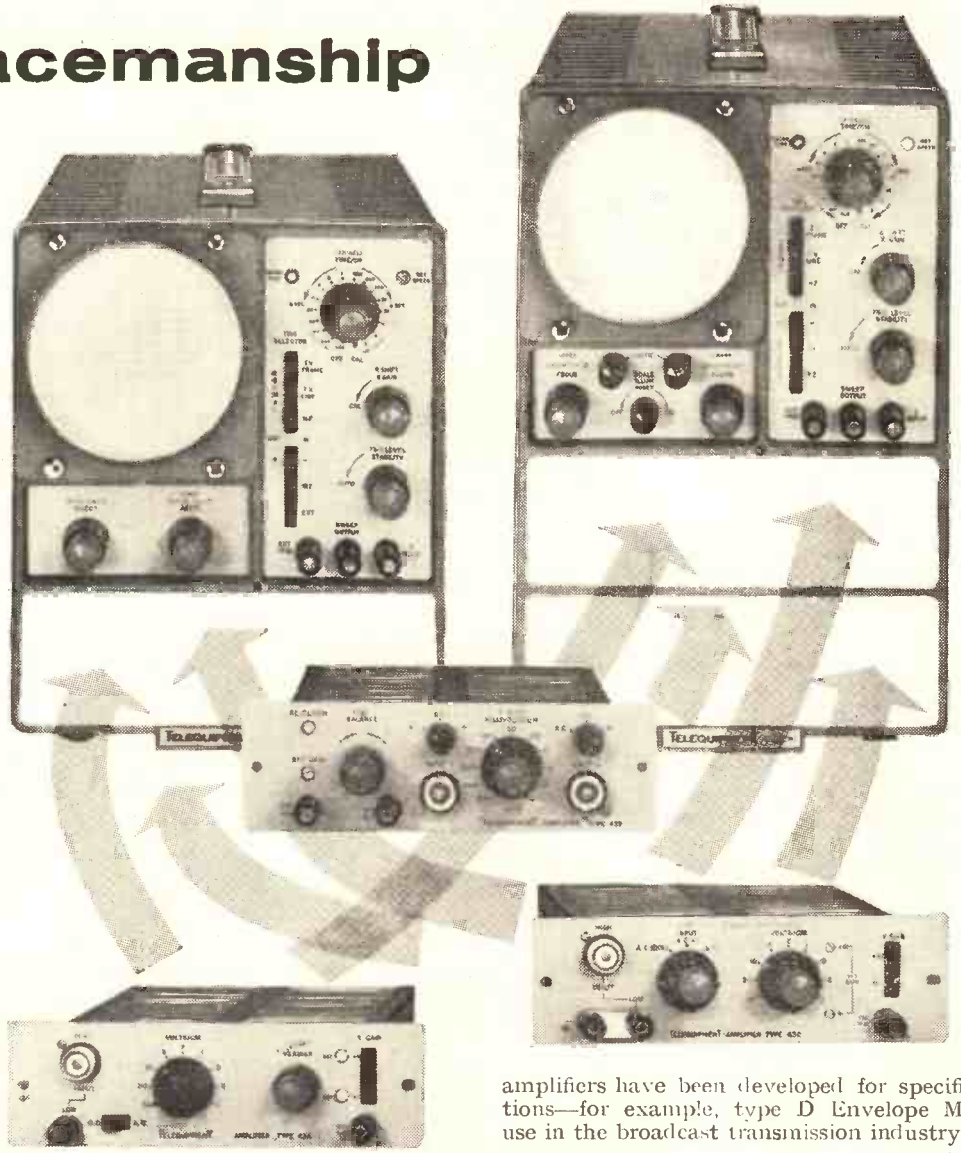

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(Bandwidths—3 dB approx.)

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Wireless World

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APRIL 1965

159 Editorial Comment

160 A Feedback Pulse Width Modulated Audio Amplifier — *By G. F. Turnbull and J. M. Townsend*

169 Matrix Algebra—2 — *By G. H. Olsen*

172 This Month's Conferences and Exhibitions

173 Manufacturers' Products

179 World of Wireless

181 Personalities

183 News from Industry

185 Physical Society Exhibition—List of Exhibitors

185 H.F. Predictions—April

186 Audio Fair Preview

193 Letters to the Editor

198 Electronic Laboratory Instrument Practice—4 — *By T. D. Towers*

203 Books Received

204 Audible Rate-of-Climb Indicator — *By J. M Firth*

206 Real and Imaginary — *By "Vector"*

207 Commercial Literature

208 April Meetings

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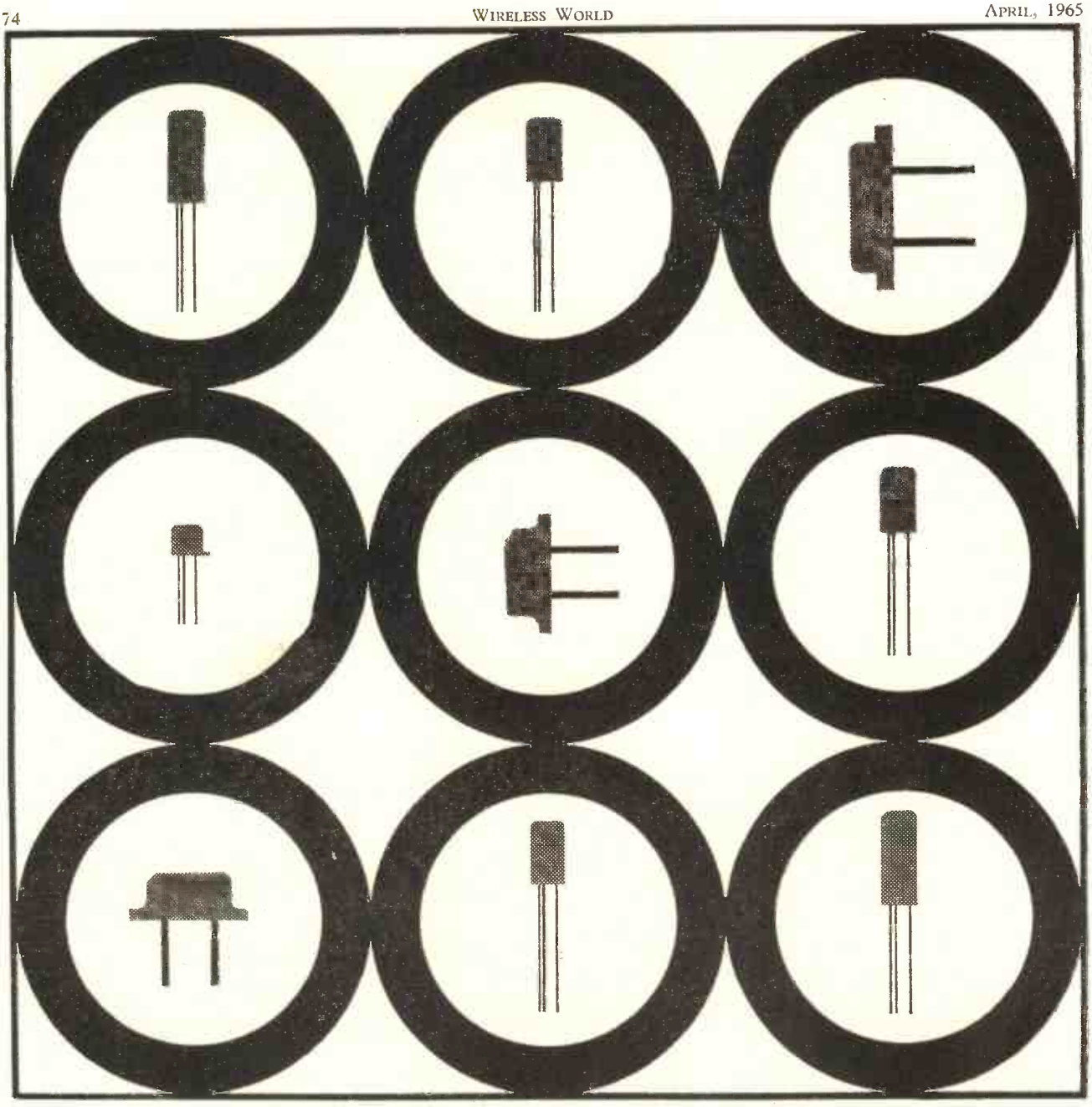

These nine Mullard Audio Transistors cover every application from 40mW to 40W

More and more transistorised equipment is becoming available for domestic entertainment. Mullard is helping to speed the day with a harmonious range of transistors for *all* audio applications: Outputs from 40mW to 40W.

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4WW—105 FOR FURTHER DETAILS.

Marconi self-tuning H.F system—
the first in the world to be station
planned from input to output.

breakthrough

MST 30kW transmitter type H1200

An h.f linear amplifier transmitter for high-grade telecommunications.
Frequency range: 4-27.5 Mc/s.
Output power: 30 kW p.e.p, 20 kW c.w.
Meets all CCIR Recommendations.

saves 80% floor space

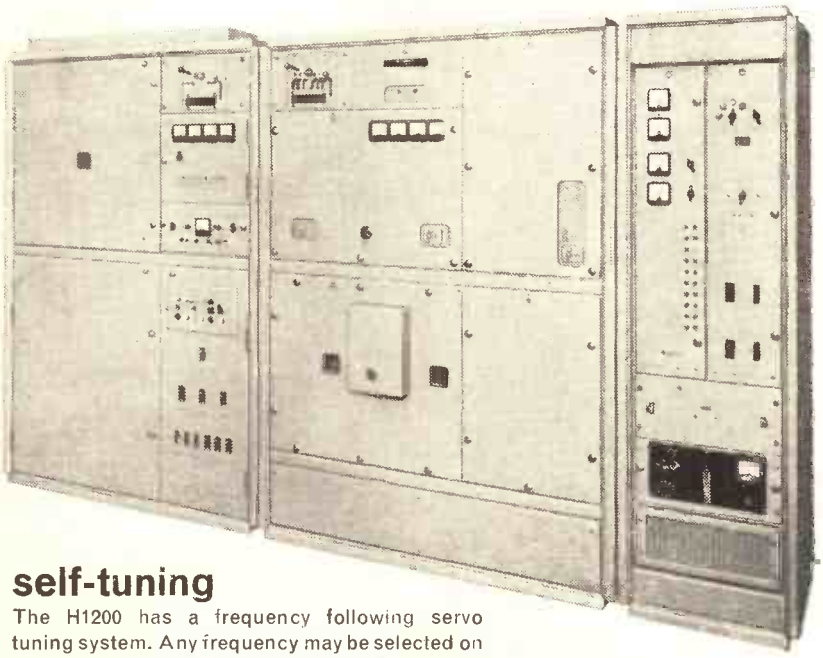
Transmitters can be mounted side by side and back to back or against a wall. Floor-ducts are eliminated and all power supply components are built-in. These features lead to smaller, simpler, cheaper buildings or more services in existing buildings.

rugged reliability

R.F circuits have been simplified and the number of mechanical parts reduced to a minimum. Highest engineering standards are applied to the design of these parts: stainless steel shafts in ball-bearings in heavy, rigid, machined castings; stainless steel spur gears meshing with silicon bronze; heavy r.f coil contacts with high contact pressure. Specified performance is maintained with ample margins.

simplicity

MST reliability allows continuous unattended operation with extended or remote control, saving maintenance and operating staff. Any fault in the servo control circuits can quickly be located with simple test routines. Transistors and printed wiring give these circuits maximum reliability.



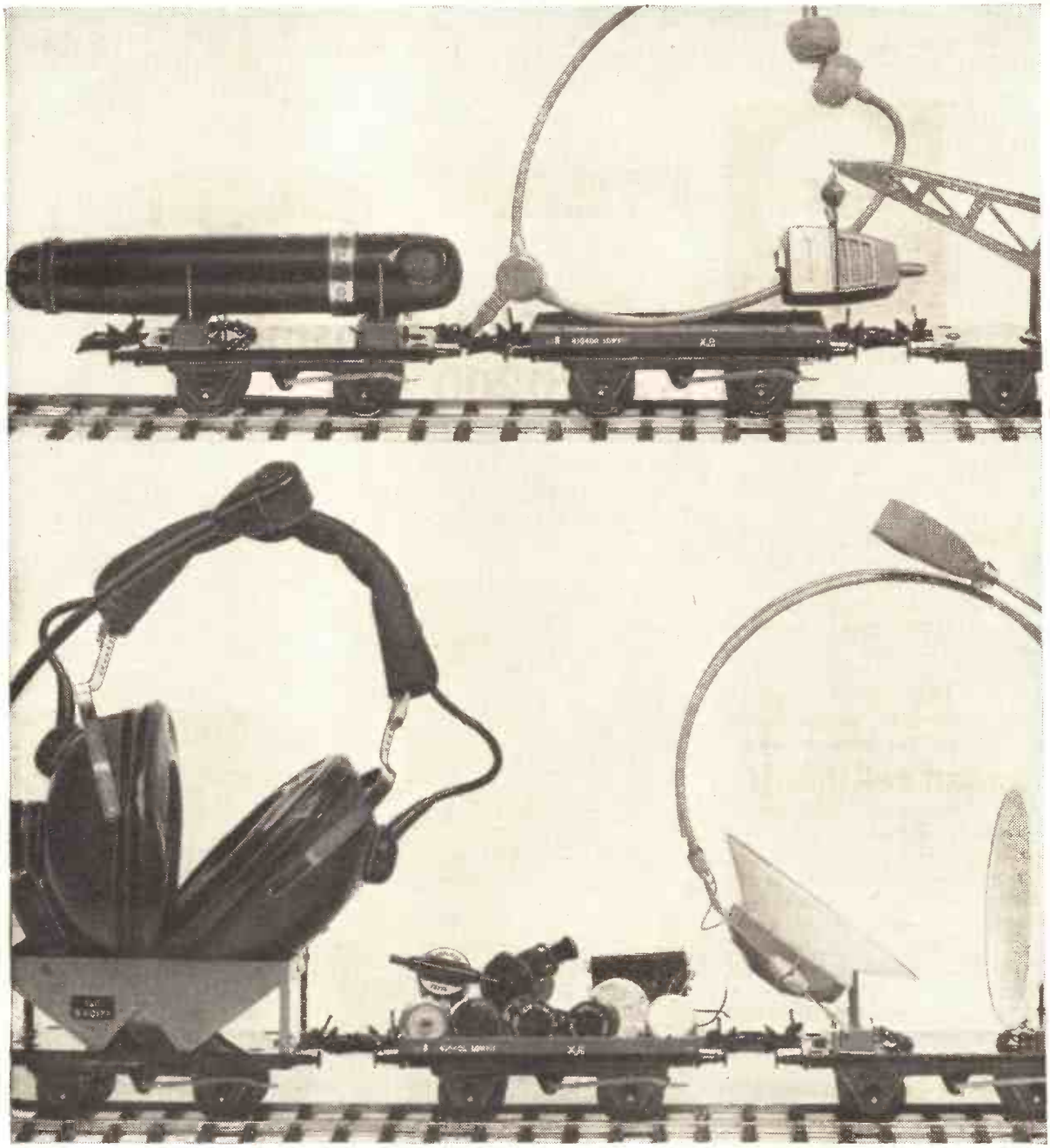
self-tuning

The H1200 has a frequency following servo tuning system. Any frequency may be selected on the synthesizer decade dials in the associated MST drive equipment; the unattended transmitter automatically tunes itself in an average time of twenty seconds. Final stage tuning and loading servos continuously ensure automatic compensation for changes in aerial feeder impedance caused by weather conditions. Self-tuning gives *one-man* control of an entire transmitting station.

Marconi telecommunications systems

The Marconi Company Limited, Communications Division, Chelmsford, Essex, England LTD/H54

4WW—106 FOR FURTHER DETAILS.



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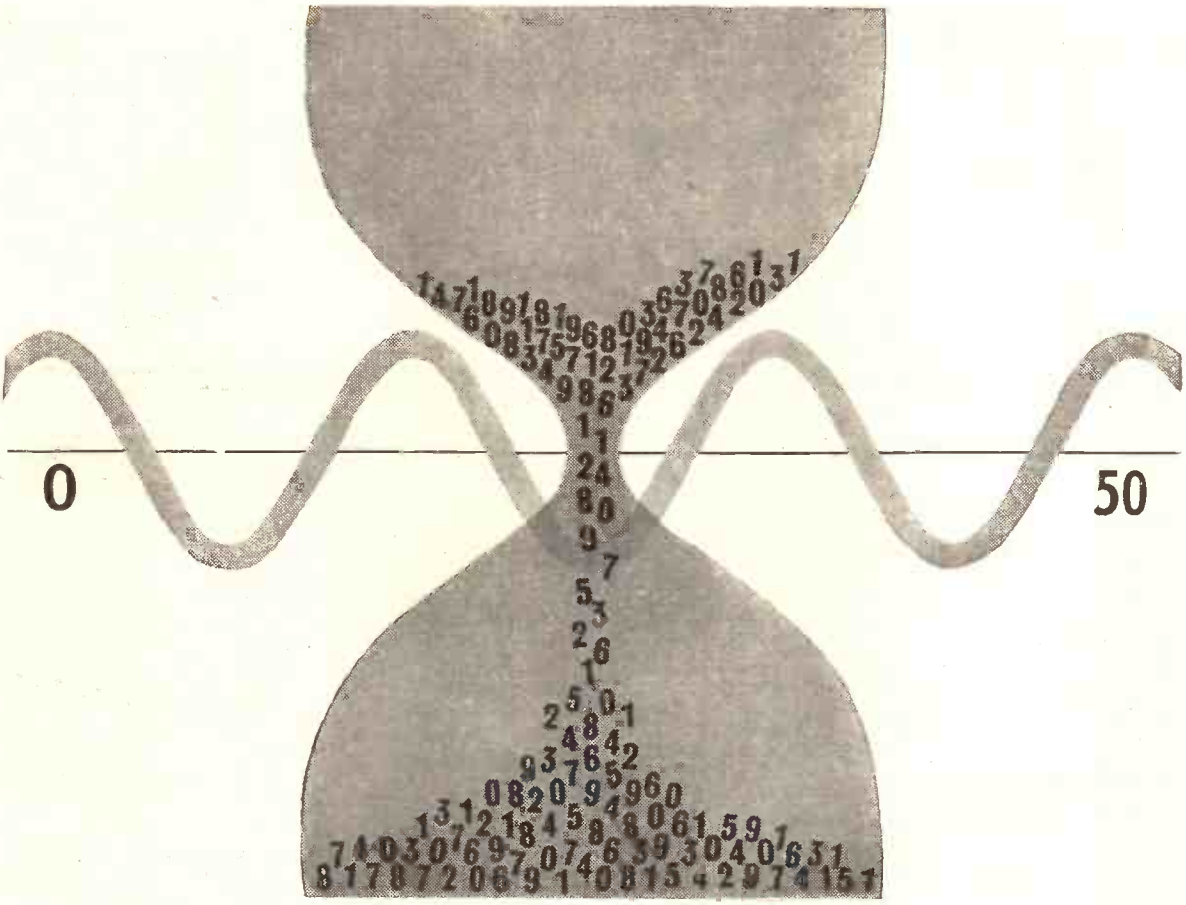

Frequency 0 to 50Mc/s—Time or Period, 1 microsecond to over 3 years

The Airmec High Speed Counter Type 298 is a basically new, fully-transistorised instrument covering the frequency range d.c. to over 50 Mc/s without the complication of additional plug-in units or external accessories. It offers in one compact unit a unique combination of facilities for time and period measurements, and for frequency measurement either by direct or inverse methods. The indicator is a large 8-figure in-line display unit showing both the units of measurement and the decimal point, combined with a 5-digit resettable electromechanical counter. For permanent records of readings, there are facilities for operating an Airmec Printer Type 316 from the Counter.

The High Speed Counter Type 298 is part of the comprehensive range of high quality electronic instruments produced by Airmec for use in laboratories and workshops.

SPECIFICATION
D.C. to 50 M/cs
12 figure digital read-out
Automatic indication of decimal point and units of measurement

MEASURES
Frequency, Time, Period

COUNTS
Pulse or Sinewave Inputs

PROVIDES
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AP 265A

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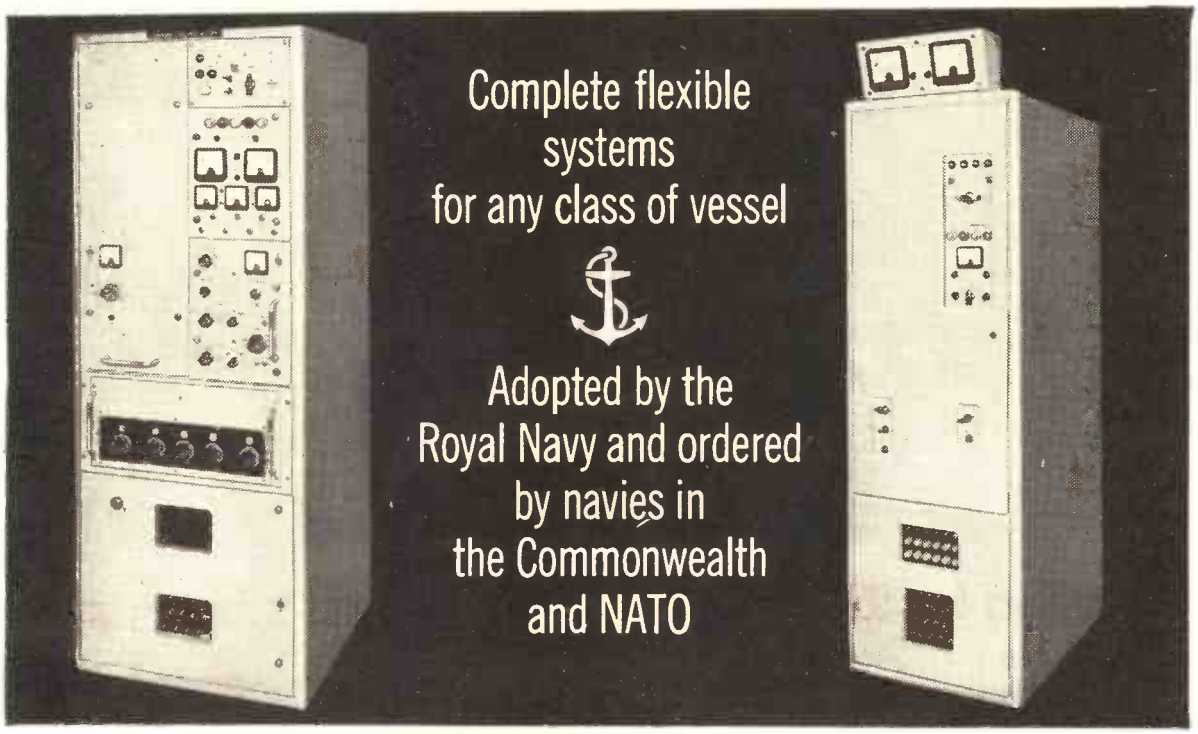
NAVAL RADIO TRANSMITTING SYSTEMS



■ Precise frequency setting and positive stability allows full advantage to be taken of SSB which provides the most reliable communications under difficult conditions of propagation or interference ■ Continuous frequency coverage from 240 Kc/s to 24 Mc/s ■ Covers all types of signalling ■ Broadband amplifier and synthesizer system provides simplest operation and almost eliminates tuning ■ Aerials can be sited for maximum radiating efficiency.

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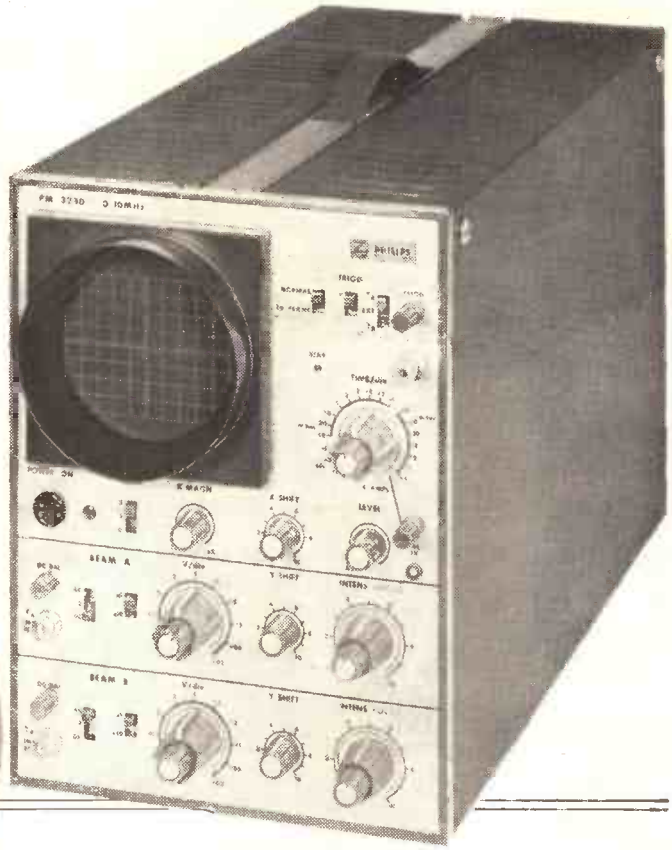

hf double beam oscilloscope

PM 3230

HIGH SENSITIVITY	LARGE BANDWIDTH
20 mV/div	0 - 10 Mc/s
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(1 division = 8 mm)	

Clear, sharp picture provided by new "side-by-side" double-gun 10 cm (4 in) cathode ray tube with full scale horizontal and vertical deflection of both beams.

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19 calibrated sweep speeds from 0.5 μs/div to 0.5 s/div, sweep expansion up to 5×

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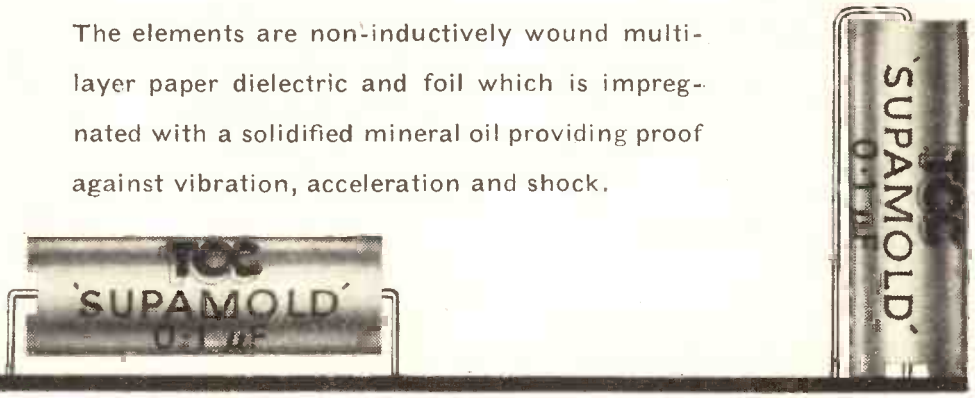

Where space is at a premium—"Duomolds" are the answer. They are smaller than paper capacitors of similar ratings, and are available for up to 1,000v. D.C. at 70°C or 750v. at 85°C. The elements are of mixed dielectric, non-inductively wound, and encapsulated in tough moulded yellow plastic tube.

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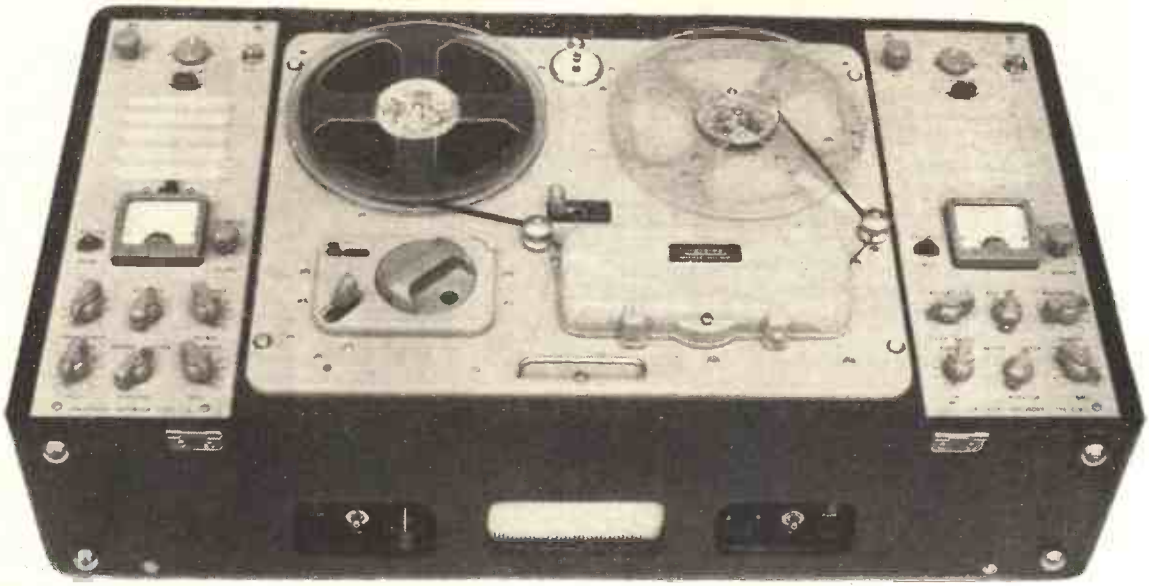
Vortexion quality equipment

TYPE C.B.L. TAPE RECORDER



Here is a versatile stereophonic recorder which has no equal in its price group.

IT CAN record monaurally or stereophonically with its own mixed inputs from Gram, Radio or other sources and from high grade low impedance balanced line microphones. With good microphones, etc. the result is a suitable master for disc manufacturers. " Before and After " monitoring is provided together with adjustable metered bias for perfection.

IT CAN also make a recording on one track and then transfer it to the other track while measuring and listening to it and adding one or two more signals also metered.

IT CAN repeat the process and transfer this combined signal to the first track with one or two more signals. Composers use it for this purpose. One track may have music or commentary and the other cueing signals or commentary and either may be altered without the other.

IT CAN playback stereophonically or monaurally with its own amplifiers of 3½ watts each.

Price £160 0s. 0d.

The Vortexion W.V.B. is a high quality monaural machine with " Before and After " monitoring. The recording inputs are a high sensitivity socket for moving coil or ribbon microphone and a high impedance socket for radio, etc. either of which can be selected by a switch. Superimposing and echo work can be done and the playback has reserve gain for abnormal requirements. This model cannot be converted for stereo playback, but it is a thoroughly reliable machine for the engineer specialising on monaural work. **Price £110 3s. 0d.**

The Vortexion W.V.A. is a monaural machine which has a performance equal in sound quality to the other models. It possesses all the features of the W.V.B. except for " Before and After " monitoring, Dubbing and Echoes. The recording being made can be heard on the internal loudspeaker as in the W.V.B. and C.B.L. The controls are uncomplicated. **Price: £93 13s. 0d.**

All tape recorders have adjustable bias controls, low impedance mic. inputs for unlimited lengths of cable, highly accurate position indicators and meters to measure recording level and bias.

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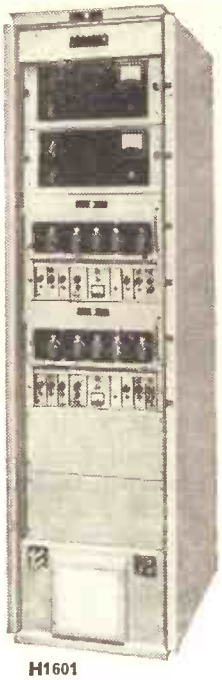
Marconi Self-Tuning H.F System
—the first in the world to be station planned from input to output

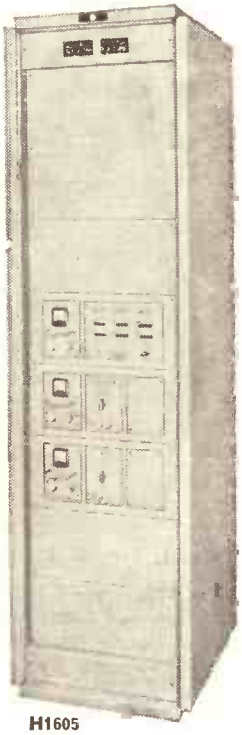
MST breakthrough

MST drive systems for h.f transmitters

MST drive systems meet all CCIR Recommendations



H1601



H1605

H1601

Comprehensive synthesizer drive assembly for two independent transmitter channels
Inputs: audio frequencies (6 kc/s bandwidth) or d.c
Outputs: modulated signals at radiated frequencies, 2 W p.e.p
Types of modulation: i.s.b with floating carrier, pilot carrier or fully suppressed carrier; d.s.b; c.w 400 bauds; f.s.k 200 bauds or 3500 bauds; frequency shift diplex
Frequency range: 2—27.9999 Mc/s
Frequency selection by decade dials on frequency synthesizers
Stability: determined by 1 Mc/s master frequency

H1605

1 Mc/s master frequency source
Frequency stability: $\pm$ 1 part in 10^8

one-man control

With the compact MST drive system, self-tuning transmitters and MST control and monitoring equipment, one man can operate an entire transmitting station from a central point.

reliability

All units (except the distributed amplifier) are fully transistorized and use printed wiring. Each unit has a separate power supply. The 1 Mc/s master signal distribution is duplicated, and the master frequency source uses three oscillators to ensure immediate automatic changeover in the event of output failure or excessive frequency drift.

versatility

Any drive channel can generate any type of modulation. F.S.K and f.s diplex signals are generated by shifting the frequency of 2 kc/s or 4 kc/s tones—thus one transmitter can radiate simultaneously two or more telegraph channels and an s.s.b channel.

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Marconi telecommunications systems

The Marconi Company Limited, Communications Division, Chelmsford, Essex, England LTD/H52

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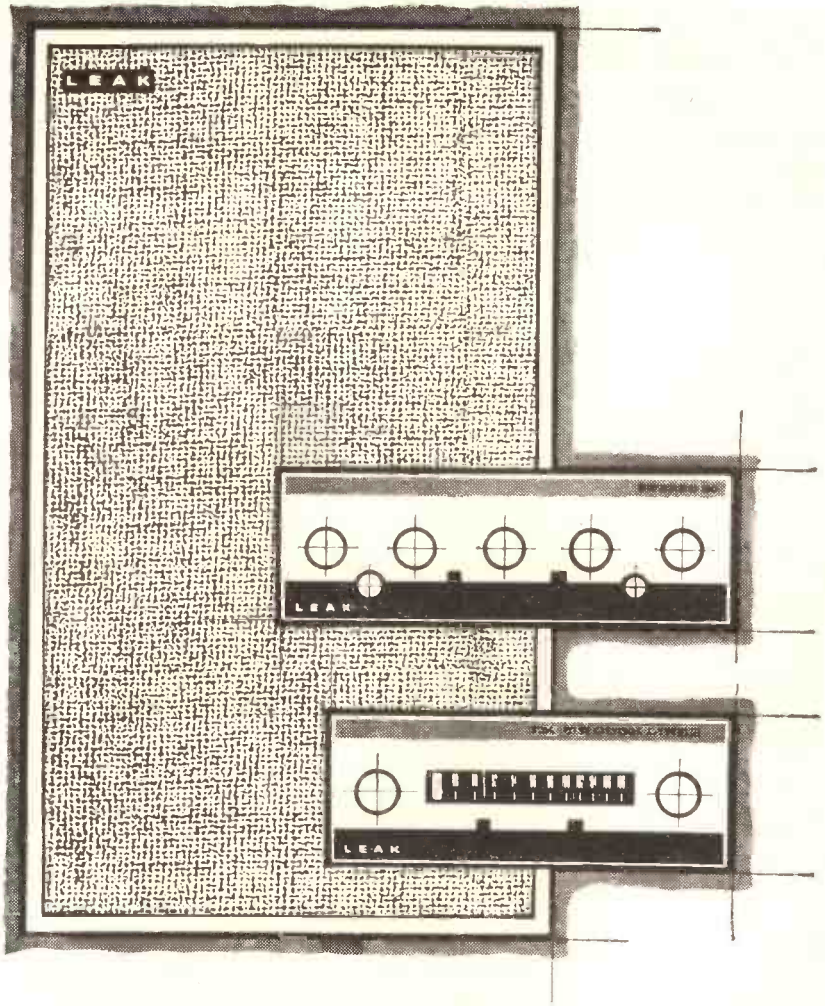

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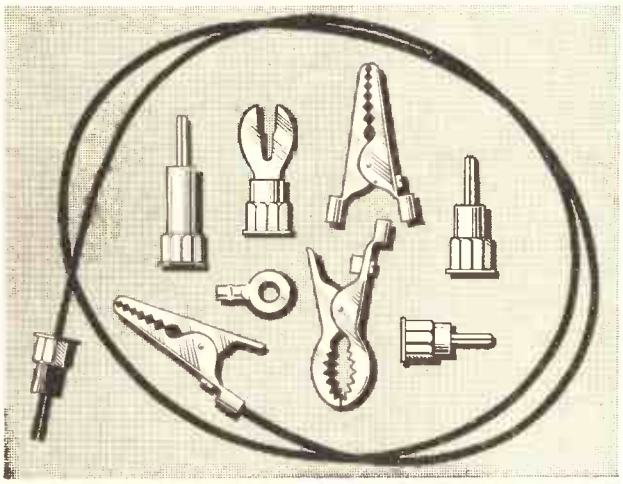

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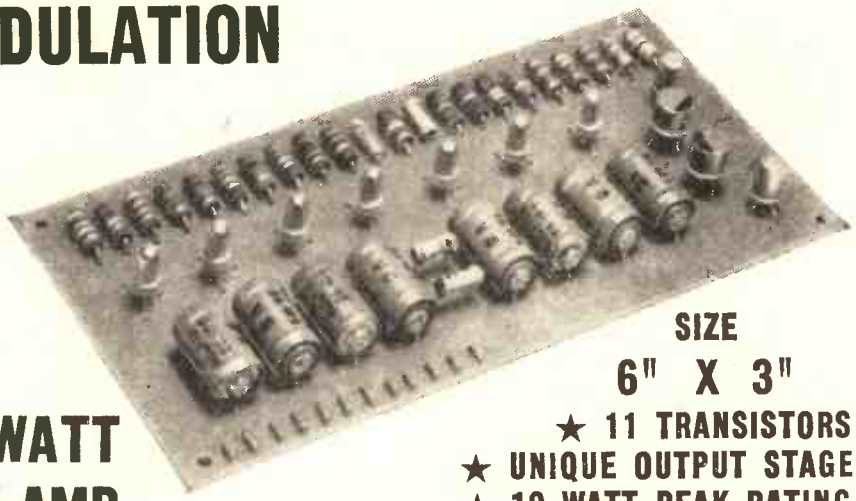

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- ★ 10 WATT PEAK RATING
- ★ 15 OHMS OUTPUT

Hi-Fi quality for very low cost

- ★ INPUT SENSITIVITY 1 mV into 1 K ohms
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- ★ SUITABLE FOR ALL TYPES OF PICK-UPS
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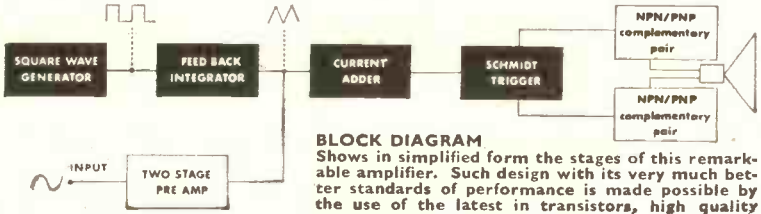

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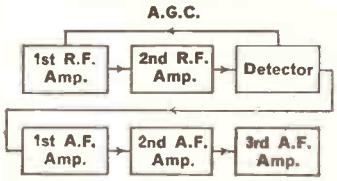

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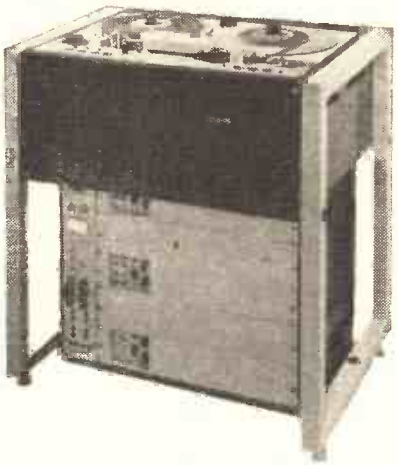

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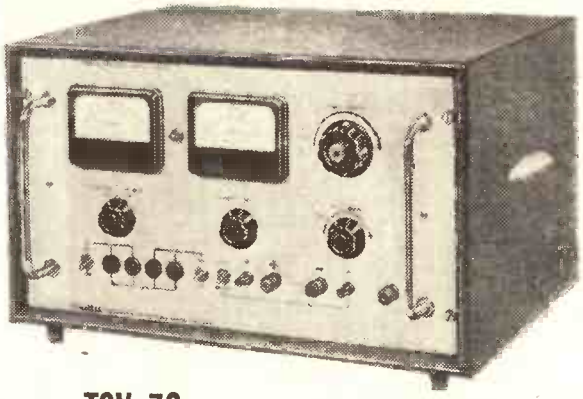

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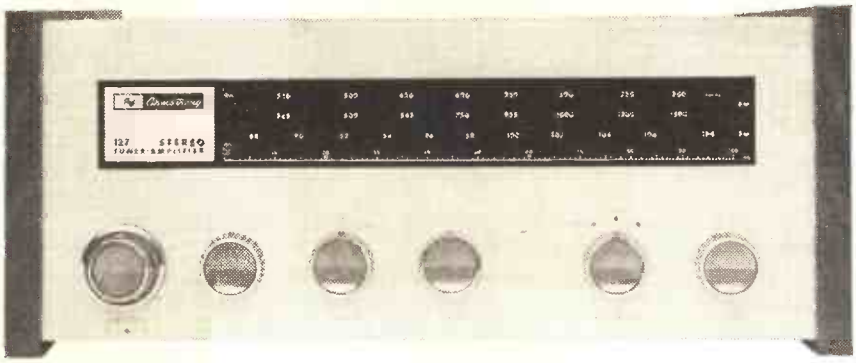

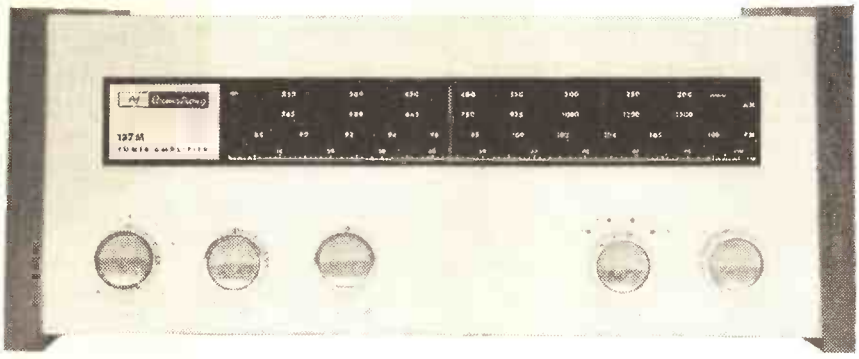

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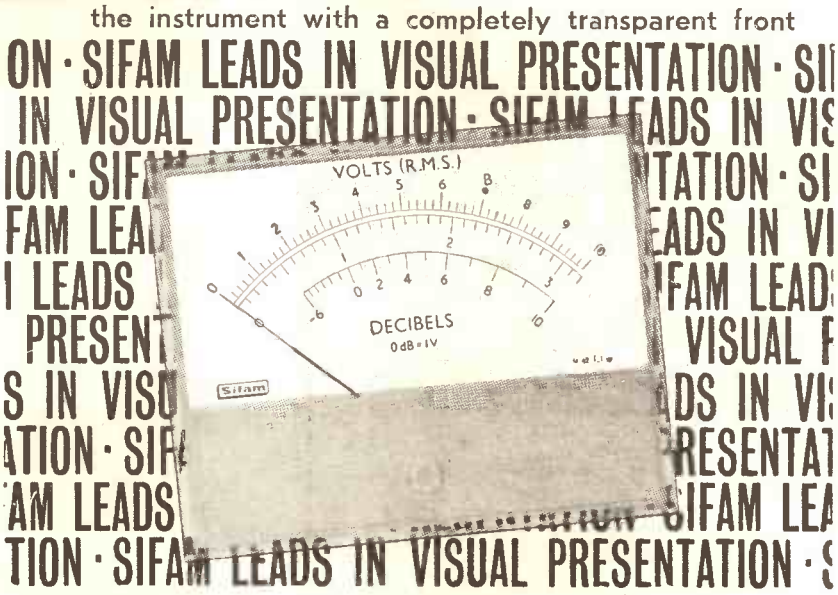

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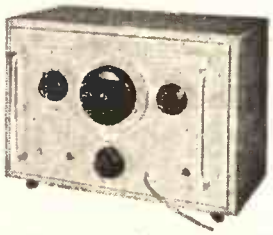

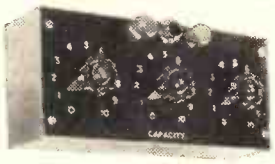

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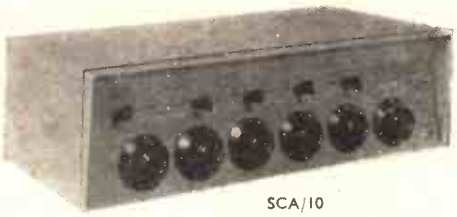

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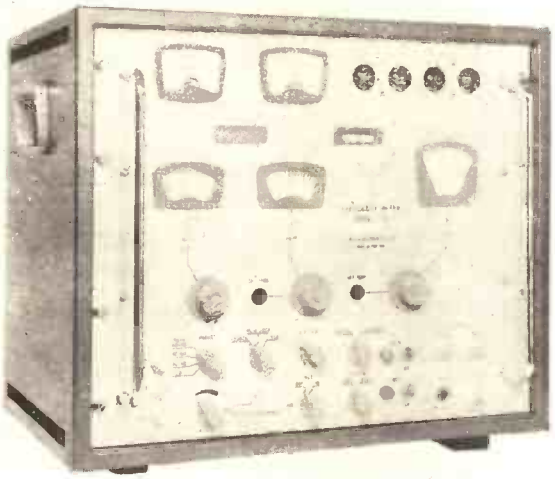

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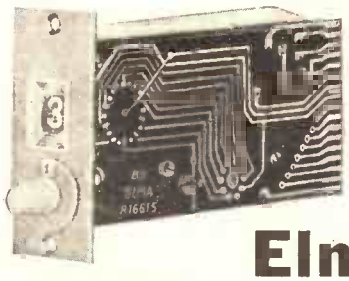

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MARCONI SIGNAL GENERATOR TF-517. Three ranges. 18 to 58 Mc/s. in 2 individually calibrated ranges and 160 to 300 Mc/s. by **DIRECTLY** calibrated dial. A.C. mains operation. **AS NEW CONDITION.** in original transit cases with instruction book. **£7/10/-.** Carr. £1.

PORTABLE RECEIVER TESTER MARCONI INSTRUMENTS TF-888/3
This instrument combines the functions of a wide range signal generator and output meter. Continuous frequency coverage of 70 kc/s. to 70 mc/s. in 8 wavebands by means of a rotating coil turret. Output impedances 80 or 52 ohms or high level (500 mV) 40Ω Int. Mod. at 1000 c/s. Two crystal checks at 500 kc/s. and 5 mc/s. Panel meter monitors carrier and also functions as output meter full scale 10 mv., 100 mV. and 1 w. Input impedances 3, 33, 150 and 600Ω. Handsome grey case size 15½ x 7½ x 11½ high. Wt. 17½ lbs. Operates from A.C. mains 100 to 250 volts. As new, tested and guaranteed, **£39/10/-.** Carr. 10/-.

MARCONI TF987/1 NOISE GENERATORS. DETERMINE NOISE FACTOR of A.M. & F.M. receivers. A.C. mains operation. Stabilised. H.T. AS NEW. Tested, **£15**, carr. 7/6. SLIGHTLY USED (but tested), **£8/19/6**, carr. 7/6.

RADIATION METERS
Portable dose rate meter containing modern type rectangular 50 micro-amp meter CVX 494, electrometer valves, etc. BRAND NEW. In canvas carrying case. **£3/19/6.** Post 4/-.

SIGNAL GENERATOR CT-53
A precision instrument covering 8.9 to 15.5 Mc/s. and 20 to 300 Mc/s. in six ranges. Variable attentuator from 1μV to 100 millivolts. A.C. mains operation. Good condition, tested and complete with calibration charts. **£16/10/-.** Carr. 10/-.

TS-175 HETERODYNE FREQUENCY METER
A high frequency version of the well-known BC-221. Accuracy 0.05%. Frequency range 80 to 1,000 Mc/s. As new condition with original calibration book. Tested and guaranteed. **£75.**

BC221 FREQUENCY METER 126 kc/s. to 20 Mc/s.
This crystal controlled heterodyne frequency meter is too well-known to need further description. Those we offer are complete with correct individual calibration book and are carefully tested and guaranteed. Used condition. Carr. 10/-. **£16**
Laboratory Standard £25

GENERAL RADIO LR2 HETERODYNE FREQUENCY & CALIBRATOR EQUIPMENT. BRAND NEW. £75

LM-14 HETERODYNE FREQUENCY METER
Naval version of the BC-221. 125 Kc/s to 20 Mc/s. Undoubtedly superior to the BC-221 in construction and performance. Requires 12 or 24 v. LT and between 200 and 475 v. HT (self-stabilised). A particularly useful feature is variable RF coupling and modulation is also available. With correct individual calibration books. Unused and guaranteed. **£25.** P. & P. 7/6. Separate power unit for A.C. (if required) **£4/10/-.** P. & P. 5/-.

G.E.C. RECEIVER BRT402E
14 valve superhet 150-385 Kc/s, 510 Kc/s to 30 Mc/s in six wavebands. Sensitivity, sig./noise ratio, freq. stability etc. of the highest order. Six step variable selectivity, Xtal filter (Xtal phasing control), RF, IF and AF gain, 500 Kc/s Xtal cal., Audio Filter, "S" meter, Ae trimmer, Variable BFO, A.C. mains operation. EVERYTHING. Reconditioned. **£60.** Carr. 30/-. S.A.E. for details.

RECEIVER R.107T
This receiver covers from 1.2 Mc/s to 17.5 Mc/s continuously in three wavebands. It is completely self-contained with built-in speaker and power unit for operation from A.C. Mains or 12 volt battery. Those we offer are guaranteed perfect. **£15.** Carriage 30/-.

WIRELESS STATIONS B 43/R 220
This is a complete mains operated (200-250 v. 50 c/s) transmitter and receiver in one metal case, size 21½ x 12½ x 18½in. and weight 90 lbs. They are for fixed frequency operation and are crystal controlled. Frequencies are between 60 and 100 Mc/s and the transmitter and receiver are not on the same frequency each using a separate crystal. Technical handbooks are supplied and it is not very difficult to alter the frequency of either or both sections. Transmitter output is 12 watts, the receiver has a built-in monitor speaker. There are 14 valves in the receiver and 8 valves in the sender. The whole station is supplied complete with all cables, connectors, feeder matching units, headphones, telephone hand set, a complete set of spare valves for receiver, transmitter and power unit. (In addition to those fitted.) Packed in a wooden case (total weight about 200 lbs.). Special note.—We cannot undertake to supply any particular frequency under any circumstances. BRAND NEW. **£25.** Carr. 50/-.

HIGH STABILITY POWER UNIT
Solartron Type SRS 156B. Designed to give ± 150 v. at 0-40mA. 6.3 v. 4 a. C.T., 6.3 v. 1 a. Operates from A.C. mains 100 to 250 v. 40 to 60 c/s. Size 9 x 6 x 6½in. high. Ripple and noise less than 350μV. Stability factor greater than 400 : 1. Source impedances less than 2Ω. BRAND NEW. **£5.** Post paid.

CANADIAN CRYSTAL CALIBRATOR
As used in Wireless Set No. 52. Gives marker pips at 1 Mc/s. 100 Kc/s and 10 Kc/s intervals. Harmonics are available up to 30 Mc/s. Incorporates a twin 1 Mc/s/100 Kc/s crystal and uses a multivibrator circuit for 10 Kc/s. Requires 12 v. L.T. and 150 v. H.T. Complete with valves, circuit of 52 set and operational notes. **BRAND NEW. 57/6,** plus 2/6 post.

MAGNETIC COUNTERS (Ex-G.P.O.). 4 figures to 9,999 Coils 500Ω for 24 v. operation. Tested (No reset). **5/-** each. P. & P. 1/6. SPECIAL OFFER. 10 for **30/-.** P. & P. 5/-.

ABSORPTION WAVEMETERS
MARCONI TF-643B. Covers from 20 to 300 Mc/s. in four plug-in coil ranges. Complete with individual calibration charts. Accuracy 1%. Indication is on a 50μA 2½in. panel meter. In original transit cases. Condition as new **£5/19/6.** Carr. 7/6.

RELAYS G.C.E. MINIATURE SEALED

M–1099. 670Ω 2M H/D Wire Ends	7/6
M–1052. 5,000Ω 2/CO. Plat. Wire Ends	10/–
M–1092 670Ω 4/CO. Plat. Wire Ends	12/6

ALL BRAND NEW AND BOXED. Please add postage.

MINIATURE RELAYS. 240 v. A.C. coils. Contact assembly 2 "makes" and 1 C.O. 5 amps. Size 2 x 1½ x 1in. Unused and removed from brand new equipment. **8/6** post paid.

STANDARD SIGNAL GENERATOR MARCONI TF-144G/4 £16/10/- Carr. 30/-.
Complete and in apparently very good condition but sold as received from the Air Ministry, i.e., untested and less leads. Technical manual and circuit supplied. We assure potential customers that "untested" does NOT mean "beyond economical repair" but are willing to supply GUARANTEED WORKING instruments complete for **£25.**

HEATHKIT & JASON AGENTS

CHARLES BRITAIN (Radio) LTD.

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Near Leicester Sq. Station. (Opposite Thorn House)
Shop hours: 9-6 p.m. (9-1 p.m. Thursdays). Open all day Saturday.

SANGAMO WESTON VOLTMETERS
561. Dual range 0-5 and 0-100 v. D.C. FSD 1 m/A. 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads. **BRAND NEW.** Boxed **32/6.** Post 2/6.

MICROAMMETERS
R.C.A. 0-500 microamps 2½in. circular flush panel mounting. Dials are engraved 0-15, 0-600 volts. As used in the American version of the No. 19 set. **15/-.**

INDUSTRIAL METER. Iron clad. 0 to 300 v. A.C. 50 cycles. Moving iron, 6in. scale Fl. mtg. BRAND NEW. **59/6.** P. 4/-.

KILOWATT METER 0-16 KVA. 3 phase 6in. scale. Boxed. New. **£5.** P. & P. 6/6.

A.C. VOLTMETER. 0-300 volts Moving Iron. Flush panel mounting. Barrel diameter. 2½in. **22/6.**

AR-88 SPARES

R.C.A. Headphones	12/6
Escutcheons (Windows)	8/6
Knobs. Medium size. Set of 8	10/–
Block Condenser (3 x 4 mfd.)	7/6

PHASE MONITOR ME-63/U (AN/URM-67)
Designed to measure directly the phase angle between two applied audio frequency signals of from 20 to 20,000 c.p.s. ±1°. Direct indication on a panel meter. Input can be sinusoidal or non-sinusoidal from 2 to 30 volts peak. Of recent manufacture (1957) by Control Electronics Inc. and ex-U.S.A. Air Force. In first class condition with handbook. A complex instrument with 19 valves. **£40.** Carr. 30/-.

MOVING COIL PHONES. Finest quality Canadian with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. **22/6.** Post 1/6. As above but complete with moving coil microphone. **25/-.** Post 2/6. DLR-5 Low impedance headphones with attached throat microphone. **12/6.** Post 1/6. All these items BRAND NEW.

T.C.C. VISCONAL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71°C. CP 152 v. Size 3 x 1¾ x 5in. high. BRAND NEW (boxed), **8/6** each. **DUBILIER NITROGOL.** 8 mfd. 350 v. D.C. wkg. at 71°C. Size 1¾ x 1¾ x 4¾in. high. With fixing clips. BRAND NEW (boxed), **5/-** each. **T.C.C.** or **DUBILIER.** 4 mfd. 600 v. wkg. CP 130T or similar. 1¾ x 1¾ x 4¾in. high. BRAND NEW (boxed), **4/6** each. All post paid.

ASSORTED CAPACITORS. Mixed parcel of 100 all brand new, marked value quality types. Silver mica, ceramicon and feed through from 1 pF to 3,000 pF. **10/-.**

STANDARD TRANSFORMERS
Vacuum impregnated, interleaved, E.S. screen, universal mounting. Size 4 x 3½ x 2½in. ALL BRAND NEW. **18/6** each. Post 2/6.
Type 1. 250-0-250 v. 80 m/a. 6.3 v. 3 a. tapped at 4 v. 4 a. 6.3 v. 1 a. tapped at 4 v. and 5 v. 2 a.
Type 2. As above but 350-0-350 v. 80 m/a.
Type 3. 30 v. 2 a., tapped at 12, 15, 20 and 24 v. to give 3-4-5-6-8-9-10 v., etc.
Type 5. 0-6-9-15 v. 4 a. Ideal for chargers.

ADVANCE CONSTANT VOLTAGE TRANSFORMERS. Input 190-260 v. 50 c/s. A.C. mains. Output 230 v. 150 watts. **£7/10/-.** Carr. 5/-.

OSCILLOSCOPE TRANSFORMER
These are replacements for the Cossor 339A 'scope. BRAND NEW in original packing. Only a limited number. **79/6.** P. & P. 5/6.

Why NOT BUILD ONE OF OUR PORTABLE TRANSISTOR RADIOS . . .

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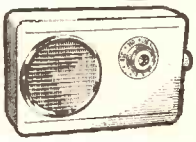


NEW TRANSONA FIVE

★ 7 Stages—5 transistors and 2 diodes.

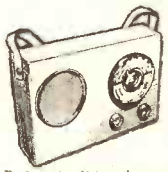
Covers M. and L. Waves and Trawler Bands, a feature usually found in only the most expensive radios. On test, Home, Light, 208, and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and new type fine tone super dynamic 2¾in. speaker, attractive case in grey plastic with red grille. Size 6½ × 4½ × 1¾in. approx.

Total cost of all parts NOW ONLY **42/6** P. & P. 3/6.
Parts price list and easy build plans 2/-.

POCKET FIVE

★ 7 Stages 5 transistors and 2 diodes. Covers Medium and Long Waves and Trawler Band, a feature usually found in only the most expensive radios. On test, Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and fine tone 2¾in. moving coil speaker, built into attractive black case with red speaker grille. Size 5½ × 1½ × 3½in. (Uses 1289 battery, available anywhere.)

Total cost of all parts NOW ONLY **42/6** P. & P. 3/-.
Parts price list and easy build plans 1/6.



ROAMER SIX NEW!!

★ 8 stages 6 transistors and 2 diodes. ★ 6 waveband.
★ Now with Philco micro-alloy R.F. transistors.

Listen to stations half a world away with this 6 waveband portable. Tunable on M. and L. waves, Trawler Band and three Short waves. Push-pull output. Sensitive ferrite rod aerial and telescopic aerial for short waves. Top grade transistors. 3-inch speaker, handsome case with gilt fittings. Size 7½ × 5½ × 1¾in. ★ Extra band for easier tuning of LUX. etc.

Total cost of all parts NOW ONLY **£3.19.6**

Parts price list and easy build plans 2/-. Carrying Strap 1/6 extra. P. & P. 3/6.

ROAMER SEVEN Mk. III

5 WAVEBAND PORTABLE OR CAR RADIO AMAZING PERFORMANCE AND SPECIFICATION

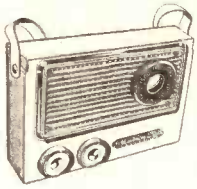
★ *NOW WITH PHILCO MICRO-ALLOY R.F. TRANSISTORS.*

★ 9 stages 7 transistors and 2 diodes.

Covers M. and L. Waves, Trawler Band and two Short Waves to approx. 15 metres. Push-pull output for room-filling volume from rich toned heavy duty 'Celestion' speaker. Air spaced ganged tuning condenser. Ferrite rod aerial for M. & L. Waves and telescopic aerial for S. Waves. Real leather look case with gilt trim and shoulder and hand straps. Size 9 × 7 × 4in. approx. The perfect portable and the ideal car radio. (Uses PP7 battery available anywhere.)

Total cost of all parts NOW ONLY **£5.19.6.** P. & P. 5/6.

Parts price list and easy build plans 3/-.



SUPER SEVEN

★ 9 Stages 7 transistors and 2 diodes.

Covers M. and L. Waves and Trawler Bands. The ideal radio for home, car or can be fitted with carrying strap for outdoor use. Completely portable—built-in ferrite rod aerial for wonderful reception. Special circuit incorporating 2 R.F. stages, push-pull output, 3in. speaker (will drive larger speaker). Size 7½ × 5½ × 1¾in. (Uses 9v. battery, available anywhere.)

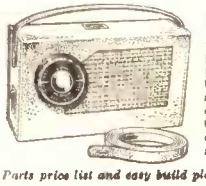
Total cost of all parts NOW ONLY **£3.19.6**
Parts price list and easy build plans 2/-. P. & P. 3/6.

NEW!! TRANSONA SIX

★ 8 stages—6 transistors and 2 diodes.

A top performance receiver covering full M. & L. Waves and Trawler Bands. Push-pull output. High-grade speaker makes listening a pleasure. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6½ × 4½ × 1¾in. (Uses PP4 battery, available anywhere.)

Total cost of all parts **59/6** P. & P. 3/6.
Parts price list and easy build plans 2/-.



MELODY SIX NEW!!

★ 8 stages—6 transistors and 2 diodes. Our latest completely portable transistor radio covering M. and L. waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208, and many Continental stations. Handsome leather look pocket size case, only 6¾ × 3½ × 1¾in. approx. with gilt speaker grille and hand and shoulder straps.

Parts price list and easy build plans 2/-. Total cost of all parts **£3.9.6** P. & P. 3/-.

All components used in our receivers may be purchased separately if desired. Parts price lists and easy build plans supplied free with sets of parts or available separately at prices stated.
OVERSEAS POST 10/-.

RADIO EXCHANGE

61, HIGH ST., BEDFORD. Phone: 2367

Callers side entrance Barratts Shoe Shop. *Weekdays 9-5 p.m. Sats. 9-12.30.*

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1L4	2/3	10F9	9/9	DM70	5/-	EY51	5/9	8U25	27/2	amp.	
1LD5	4/-	10F18	9/9	DY86	6/9	EY81	7/3	T41	9/-	No larger	
1LN5	4/6	10P13	8/3	DY87	8/-	EY83	9/3	TDD4	7/6	than a shirt	
1N5GT	8/6	10P14	11/6	E80F	24/-	EY84	9/6	TH41	10/-	button	
1R5	4/-	12A6	2/3	E83F	24/-	EY86	5/9	TH233	6/9	7/- each.	
1S4	5/-	12AC6	8/6	E88CC	10/-	EY88	8/9	TP22	5/-	TRAN-	
1S5	3/6	12AD6	9/6	E180F	19/6	EZ40	5/3	TP25	5/-	SISTORS	
1T4	2/3	12AE6	8/-	EA50	1/6	EZ41	6/3	TP2620	7/6	AND	
1U4	5/6	12AH8	10/9	EA76	6/9	EZ80	3/9	TY86F	11/8	DIODES	
1U5	5/3	12AT6	4/6	EABC80	5/9	EZ81	4/6	U12/14	7/6	AA129	4/6
2D21	5/6	12AU6	5/9	EAC91	3/3	FC4	8/9	U16	15/-	AC107	14/6
2X2	3/-	12AV6	6/6	EAF42	7/6	GZ33	17/6	U18/20	6/6	AC127	9/6
3A4	3/9	12BA6	5/9	EB34	1/-	GZ34	10/-	U19	48/6	AD140	25/-
3A5	6/9	12BE6	4/9	EB41	4/9	GZ37	14/6	U22	5/9	AF102	27/6
3B7	5/-	12BH7	6/-	EB91	2/3	HABC80	9/3	U24	12/6	AF114	11/-
3D6	3/9	12E1	16/9	EBC33	6/-	HL41DD		U25	8/6	AF115	10/6
3Q4	5/3	12J7GT	7/3	EBC41	6/6		12/-	U26	7/6	AF116	10/-
3Q5GT	7/-	12K5	10/-	EBC81	5/9	HL42DD		U31	7/-	AF117	5/6
3S4	4/6	12K7GT	3/6	EBF80	5/9		12/-	U33	13/6	AF118	20/-
3V4	5/3	12K8GT	9/-	EBF83	7/3	HN309	25/-	U35	16/6	AF124	11/-
5R4GY	8/6	12Q7GT	3/6	EBF89	6/-	HVR2	8/3	U37	29/-	AF125	10/6
5U4G	4/6	12SA7	6/9	EBL21	10/6	HVR2A	8/9	U45	15/6	AF126	10/-
5V4G	8/-	12SC7	4/-	EC92	6/6	KT33C	4/-	U76	4/6	AF127	9/6
5Y3	4/9	12SK7	3/-	ECC32	4/-	KT36	29/1	U101	19/6	BYZ13	11/6
5Z3	6/6	12SQ7	8/-	ECC33	29/1	KT41	7/6	U191	9/6	MAT100	7/9
5Z4G	7/6	14H7	9/6	ECC34	21/7	KT44	5/-	U281	8/9	MAT101	8/6
6A8	5/9	19AQ5	7/3	ECC35	5/3	KT61	6/9	U282	12/3	MAT120	7/9
6AG5	2/6	19H1	6/-	ECC40	7/-	KT63	3/9	U301	11/6	MAT121	8/6
6AG7	5/9	20D1	10/-	ECC81	3/6	KT66	12/3	U329	9/-	OA5	6/-
6AK5	4/9	20D2	21/-	ECC82	4/6	KT88	28/-	U403	9/9	OA10	6/6
6AQ5	5/9	20F2	11/6	ECC83	4/6	KTW61	4/9	U404	6/-	OA70	3/-
6AT6	3/9	20L1	12/6	ECC84	5/6	KTW62	5/6	U801	16/3	OA73	5/-
6AU6	5/9	20P1	12/6	ECC85	5/9	KTW63	5/6	U4020	6/6	OA79	3/-
6AV6	5/6	20P3	12/-	ECC88	8/9	MHLD6	12/6	UABC80	5/-	OA81	3/-
6B8G	2/6	20P4	13/6	ECC189	11/6	MU14	2/6	UAF42	7/-	OA85	3/-
6BA6	4/6	20P5	12/3	ECC807	15/-	N37	10/6	UB41	10/6	OA86	4/
6BE6	4/9	25A6G	7/6	ECF80	6/6	N78	26/-	UBC41	8/3	OA90	3/-
6BG6G	13/6	25L6	4/9	ECF82	6/3	N108	26/2	UBC81	6/3	OA91	3/-
6BH6	5/3	25Z4G	7/-	ECF86	11/6	N339	15/-	UBF80	5/9	OA95	3/6
6BJ6	5/6	25Z5	7/3	ECF804	24/-	PABC80	6/9	UBF89	6/9	OA210	9/6
6BQ7A	7/6	27SU	23/3	ECH21	9/-	PC86	10/3	UBL21	10/9	OA211	13/6
6BR7	8/3	28D7	6/9	ECH35	6/3	PC88	9/6	UC92	6/3	OC16W	35/-
6BR8	8/-	30C1	6/6	ECH42	8/-	PC95	6/9	UCC84	8/9	OC19	25/
6BS7	25/-	30C18	10/6	ECH81	5/9	PC97	6/9	UCC85	6/6	OC22	23/-
6BW6	8/9	30F5	5/9	ECH83	6/6	PCC84	5/6	UCC86	8/9	OC23	57/-
6BW7	5/-	30L1	5/6	ECH84	9/6	PCC85	6/9	UCH21	8/-	OC25	12/-
6C5	4/-	30L15	9/3	ECL80	6/-	PCC88	10/6	UCH42	8/-	OC26	8/-
6CD6G	18/-	30P4	12/3	ECL82	6/6	PCC89	8/6	UCH81	6/6	OC28	23/-
6CH6	5/-	30P12	7/6	ECL83	9/6	PCC189	10/6	UCL82	7/9	OC29	16/6
6CW4	24/-	30P19	12/3	ECL86	8/9	PCF80	6/6	UCL83	9/-	OC35	9/6
6D3	9/6	30PL1	10/6	EF9	20/6	PCF82	6/3	UF41	6/9	OC36	21/6
6E5	9/6	30PL14	12/6	EF22	6/6	PCF84	8/6	UF42	4/9	OC41	8/-
6F1	9/6	35A5	20/9	EF36	3/3	PCF86	7/9	UF80	6/3	OC42	5/-
6F6G	3/9	35L6GT	8/-	EF37A	6/-	PCF801	10/-	UF85	6/9	OC43	12/6
6F13	3/9	35W4	4/9	EF40	8/9	PCF802	10/-	UF86	9/-	OC44	4/9
6F23	6/3	35Z3	16/2	EF41	6/9	PCL82	6/6	UF89	6/-	OC44PM	
6F24	9/6	35Z4GT	4/6	EF42	3/9	PCL83	11/-	UL41	7/3		11/-
6F33	3/6	35Z5GT	5/9	EF50	2/6	PCL84	7/6	UL44	23/3	OC45	4/9
6J5G	3/-	50B5	6/6	EF54	3/-	PCL85	7/6	UL46	8/6	OC45M	8/-
6J6	3/-	50C5	6/6	EF73	5/-	PCL86	8/9	UL84	6/-	OC65	22/6
6J7G	4/6	50CD6G	40/9	EF80	4/-	PEN45	7/-	UM4	15/2	OC66	25/-
6K7G	1/3	50L6GT	6/3	EF83	9/9	PEN45DD		UM34	16/10	OC70	6/6
6K8G	3/3	72	6/6	EF85	4/6		12/-	UM80	8/3	OC71	6/6
6K8GT	M8/6	78	4/9	EF86	6/6	PEN383	10/3	UR1C	6/6	OC72	8/-
6K25	24/-	80	5/3	EF89	4/-	PEN453DD		UU6	11/-	OC73	16/-
6L1	10/-	85A2	6/6	EF91	3/-		10/-	UU8	11/6	OC74	8/-
6L6GT	7/-	90AG	67/6	EF92	2/6	PENDD		UY1N	10/3	OC75	8/-
6L7GTM	5/6	90AV	67/6	EF97	10/-	4020	17/6	UY21	7/9	OC76	8/6
6LI8	10/-	90CG	42/-	EF98	10/-	PL33	9/-	UY41	5/-	OC77	12/-
6LD3	6/6	90CV	42/-	EF183	7/-	PL36	9/-	UY85	5/-	OC78	8/-
6N7GT	7/-	90C1	16/-	EF184	7/-	PL38	16/-	VM84B	12/-	OC81	4/-
6P28	11/6	150B2	16/6	EH90	7/-	PL81	6/9	VP4	14/6	OC81D	4/-
6Q7G	4/-	866A	12/6	EK32	5/9	PL82	5/3	VP4B	12/-	OC81M	8/-
6R7G	5/3	5763	7/6	EL32	3/6	PL83	6/-	VP13C	7/-	OC82	10/-
6SL7GT	5/3	AZ1	5/9	EL33	6/9	PL84	6/6	VP23	2/6	OC83	6/-
6SN7GT	4/-	AZ31	6/6	EL34	8/6	PL500	15/9	VP133	9/9	OC84	8/-
6U4GT	8/6	AZ41	6/6	EL36	8/9	PM84	9/3	VR105	5/6	OC139	12/-
6U5G	5/-	B36	4/9	EL41	7/3	PX4	9/-	VR150	4/9	OC140	19/-
6V6G	3/9	BL63	10/6	EL42	7/6	PY31	7/-	VT61A	7/-	OC170	8/6
6V6GT	5/6	CCH35	12/6	EL81	8/3	PY32	8/9	W76	3/6	OC171	9/-
6X4	3/9	CV85	14/6	EL83	6/9	PY33	8/9	W81M	5/9	OC200	10/6
6X5	4/6	CY31	5/9	EL84	4/6	PY80	5/-	X41	10/-	OC201	29/-
6/30L2	9/-	D15	13/6	EL85	7/6	PY81	5/-	X61	6/3	OC202	24/6
7A7	12/6	D43	17/9	EL86	7/3	PY82	4/9	X65	5/6	OC203	14/-
7B6	12/6	DAF96	6/-	EL91	2/6	PY83	5/9	X66	7/3	OCP71	17/6
7B7	9/6	DD4	12/6	EL95	5/6	PY88	7/3	X76M	9/-	ORP12	12/6
7C5	8/-	DD41	10/6	ELL80	13/6	PY800	6/-	X78	20/6	T82	12/6
7C6	6/9	DF66	15/-	EM4	17/9	PY801	6/3	X79	27/-	T83	15/-
7D6	14/6	DF96	6/-	EM34	11/6	R10	15/-	Y63	5/-	XA103	15/-

METAL RECTIFIERS. DRM1B 13/-; DRM2B and DRM3B 15/6; LW7 21/-; LW15 26/-; RMO 7/11; RM1 5/3; RM2 6/3; RM3 7/9; RM4 12/9; RM5 17/6; 14A86 17/6; 14A97 19/6; 14A100 23/-; 14A124 26/6; 14A163 35/6; 14B130 31/-; 14B261 11/6; FC101 16/9; 16RC1.1.16.1 8/-; FC31 21/-; 16RD2.2.8.1 11/-; 16 RE 2.1.8.1 8/6; 18RA.1.1.8.1 4/-; 18RA.1.2.8.1 11/-; FC116 6/-; FC124 12/6.

ELECTROLYTICS. Can types:— 32 × 32/450 v. 6/-; 50 × 50/350 v. 6/-; 64 × 120/350 v. 9/-; 60 × 250/275 v. 9/6; 100 × 400/275 v. 12/6; 100/275 v. 3/-; 200/275 v. 4/-; 100 × 200/275 v. 8/6; Wire-ended types:—8/450 v. 1/9; 16/450 v. 2/9; 32/450 v. 3/9; 8 × 8/450 v. 3/-; 16 × 16/450 v. 4/-; 32 × 32/350 v. 4/-; 8 × 16/450 v. 3/9; 32/350 v. 3/-;

BRIDGE RECTIFIERS. 12 v./1 amp. 6/6; 12 v./2 amp. 9/9; 12 v./4 amp. 14/6; 12 v./6 amp. 21/9; 6 v./2 amp. 6/6; 6 v./4 amp. 9/9; 6 v./8 amp. 14/6; 6 v./12 amp. 21/9: Post 1/6 each.

All goods are new, first quality brands only, and subject to maker's full guarantee. We do not handle manufacturers' seconds nor rejects, which are often described as "new and tested" but have a limited and unreliable life.

Terms of business:— Cash with order or C.O.D. only. Post/packing 6d. per item. Orders over £3 post/packing free. C.O.D. 3/6 extra. All orders cleared on day of receipt, and C.O.D. orders by telephone accepted for immediate despatch until 3.30 p.m. Any parcel insured against damage in transit for only 6d. extra. Callers welcome Mon.-Fri. 8.30-5.30, Sats. 8.30-1 p.m. Complete catal of valvoguees and components, with conditions of sale, price 6d.

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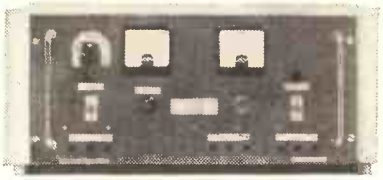
4WW—137 FOR FURTHER DETAILS.

BULK PURCHASE OF STABILISED POWER UNITS



(1) **GENERAL PURPOSE P.U.** Two adjustable independent outputs (1) — 0/250 v. at 50 mA.; (2) + 0/250 or 0/500 v. at 250 mA. Also 6.3 at 9 amps, using 5—GZ32, 3—12E1, and 7 other valves, meter for checking output voltage or current, both voltages adjustable. 19in. rack mounting × 10½in. ONLY **£14/10/-**, matching case **20/-**, B.R.S. **10/-**.

(2) **TRANSISTOR P.U. Mk. 2.** Two adjustable independent outputs (1) — 0/10, — 0/100; (2) + 0/10, + 0/100 v., metered output, and same in looks and size as above power unit, using 20 valves **£14/10/-**, matching case **20/-**, B.R.S. **10/-**.

(3) **AS ABOVE BUT** 0/15, 0/150.

(4) Three outputs 200-255, 255-350, at 200 mA.; 350-400 at 150 mA. All adjustable, 6.3 C.T. 4 amps twice, 19in. rack mounting × 8¾in., **£8/10/-**, matching case **20/-**, B.R.S. **10/-** (two meters voltage and current).

(5) **OUTPUT 120-250.** Variable at 50 mA., 6.3 C.T. 4 amps. using two meters voltage, current, 19in. rack mounting × 7in., **£5/10/-**, matching case **20/-**, B.R.S. **10/-**.

ALL ABOVE ARE NEW OR AS NEW, LESS THAN 2 YEARS OLD. MADE BY MARCONI, OR EDISWAN, ALL INPUTS 200-50 A.C.

SCINTILLATION COUNTER 1093(B), using CV2316 Photo Tube, plus 10 other valves, Magnetic Counter with lens, each unit in case but made for 19in. Rack mountings × 8¾in.

POWER UNIT 1093(B) for above, 200-50 A.C. input, output stabilised adjustable (1) 0-2 kV.; (2) 300 v. 120 mA.; Meter for checking output voltages, same size as above, using 10 valves, made by Ferranti. These two units are the complete counter, and checked complete, but as we know very little of this type of equipment no enquiries can be answered. **£12/10/-**., BRS **10/-** or either unit **£7**, BRS **10/-**.

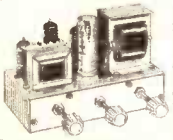
SCALING UNITS. 1009 A & B. S.A.E.

50-75 WATT TANNOY AMPLIFIER. 200-50 A.C. input using 6 valves, circuit and hand mike, also 2 spare 6L6 and 2 FW4/500 valves. **BRAND NEW, £10.** B.R.S. **10/-**.

12-VOLT-150 Vibrator Pack made for 52 set. **BRAND NEW** in sealed cartons, less 6×5 rectifier, **15/-**. Post 2/6.

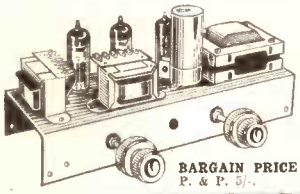
J. T. SUPPLY, 38 MEADOW LANE, LEEDS 11

3-VALVE AUDIO AMPLIFIER MODEL HA34



Designed for Hi-Fi reproduction of records. A.C. mains operation. Ready built on plated heavy gauge metal chassis, size 7½in. w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate bass, treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. The HA34 has been specially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc., wired and tested for only **£4/5/-**. P. & P. 5/-

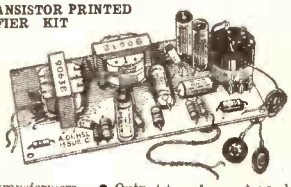
STEREO AMPLIFIER



Incorporating 2 ECL82s and 1 EZ80; heavy duty, double wound mains transformer. Output 4 watts per channel. Full tone and volume controls. Absolutely complete.

BARGAIN PRICE ONLY £4/19/6. P. & P. 5/-.

HIGH GAIN 4-TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
Type TAI



● Peak output in excess of 1½ watts. ● All standard British components. ● Built on printed circuit panel, size 6×3in. ● Generous size driver and output transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET 114 or 81 Mullard OC81D and matched pair of OC81 o/p.). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 1/6 (Free with Kit). All parts sold separately. **SPECIAL PRICE 45/-**. P. & P. 2/6. Also ready built and tested, **52/6**. P. & P. 2/6. A pair of TAIs are ideal for stereo.

SPECIAL OFFER!
Limited number of E.M.I. 4-SPEED SINGLE RECORD PLAYER DECKS
With unit mounted pick-up. Incorporating the following special features: Heavy 8¾in. metal turntable, low flutter performance shaded pole motor for 200/250 v. A.C. with 90 v. tap. Latest ultra lightweight pickup (5 grammes tracking weight). High o/p mono ceramic cartridge. Autostop. Overall motorplate size 12in. × 10in. × 2¾in. below and 2in. above.
UNREPEATABLE OFFER AT 89/6. Carr. 4/-.

4-SPEED PLAYER UNIT BARGAINS
All brand new in maker's original packing.

SINGLE PLAYERS
B.S.R. TU/12 **£3/9/6** Carr. 4/-. Garrard SRP10 **£5/9/11**, Carr. 4/-. B.S.R. GU7 with unit mounted pick-up arm. **£4/18/8**. Carr. 4/-.

AUTO. CHANGERS

Latest B.S.R. UA25 Super slim	£6	2	6
B.S.R. UA15 **£6/19/6**. B.S.R. UA16	£6	19	6
Latest GARRARD AT5	£8	8	0
GARRARD AT6	£10	10	0
GARRARD Auto-Slim	£6	10	0

Carr. 5/- on each

All the above units are complete with t/o mono head with sapphire styli or can be supplied with stereo head at **12/6** extra

BRAND NEW CARTRIDGE BARGAINS!
ACOS 71-5. Single-sided Crystal Cartridge for Stereo and L.P. records. Complete with diamond stylus and universal mounting bracket. List price £2/6/4. **OUR PRICE 18/6.** P. & P. 1/-.
GARRARD GC2 Mono complete. List price 24/11. **Our Price 12/6.** P. & P. 1/-.
RONETTE STEREO 105 CARTRIDGE. Stereo/LP/78 complete with two sapphires. Original list price **67/9**. Our Price **24/-**. P. & P. 1/-.

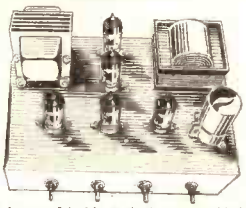
QUALITY RECORD PLAYER AMPLIFIER
A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate bass, treble and volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 2½in. d. × 5¼in. h. Ready built and tested. **PRICE 69/6.** P. & P. 3/6.
ALSO AVAILABLE mounted on board with output transformer and 6in. speaker ready to fit into cabinet below. **PRICE 89/6.** P. & P. 4/6.

QUALITY PORTABLE R/P. CABINET
Uncut motor board. Will take above amplifier and B.S.R. or GARRARD Autochanger or Single Record Player Unit. Size 18 × 14 × 8½in. **PRICE £3/9/6.** Carr. 5/-.

4-WAY NON-TANGLE TELEPHONE CABLE. Latest springback coil type, extends 12in. to 5ft. Complete with rubber bushes, **4/6** each. P. & P. 1/-.

Precision 6-minute Delay Action Switch, Clockwork actuated. Made by Smiths. Separate switching actions at intervals up to 6 mins. Each switch action designed for current loading up to 15 amps at 250 volts. Suitable for photographic timer, sequence switching operations, etc., etc. Brand new and unused units offered at a fraction of their true value. **OUR PRICE 10/-** each. Post free 2 for **17/6**. Special quotations for quantity.

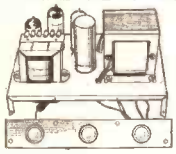
10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86, and EZ80 rectifier. Simple instruction booklet 1/6. (Free with parts.) **All parts sold seperately. ONLY £6/19/6.** P. & P. 6/6. Also available ready built and tested complete with standard input sockets, **£8/15/-**. P. & P. 6/6.

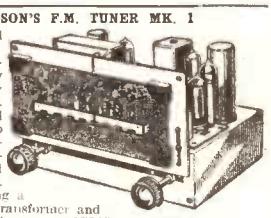
VYNAIR & REXINE SPEAKER & CABINET FABRICS. Approx. 5½in. wide. Usually 35/- yard, **OUR PRICE 13/6** per yard length. P. & P. 1/9. (Min. 1 yard). S.A.E. for samples.

A NEW HARVERSON KIT FOR THE HOME CONSTRUCTOR



A really excellent, all purpose A.C. mains 200/240 v.
AMPLIFIER KIT.
TYPE HSL "FOUR" 3-VALVE, 4 WATT USING ECC83, EL84, EZ80 VALVES.
Special features include: ★ Heavy duty double-wound mains transformer with electrostatic screen. ★ Separate bass, treble and volume controls, giving fully variable boost and cut with minimum insertion loss. ★ Heavy negative feedback loop over 2 stages ensures high output at excellent quality with very low distortion factor. ★ Suitable for use with guitar, microphone or record player. ★ Provision for remote mounting of controls or direct on chassis. ★ All this builds on to a chassis size only 7¾in. wide × 4in. deep. Overall height 4¾in. ★ All components and valves are brand new. ★ Very clear and concise instructions enable even the inexperienced amateur to construct with 100% success. ★ Supplied complete with valves, output transformer (3 ohms only), screened lead, wire, nuts, bolts, solder, etc. (No extras to buy.) **PRICE 79/6.** P. & P. 5/-.
Comprehensive circuit diagram, practical layout and parts list 2/6 (free with kit).

HARVERSON'S F.M. TUNER MK. 1



● F.M. tuning head by famous maker. ● Guaranteed non-drift. ● Permeability tuning. ● Frequency coverage. 88-100 Mc/s. ● OA81 balanced diode output. ● Two I.F. stages and discriminator. ● Attractive maroon and gold dial (7 × 3in. glass). ● Self powered, using a good quality mains transformer and valve rectifier. ● Valves used ECC85, two EF80s, and EZ80 (rectifier). ● Fully drilled chassis. ● Size of completed tuner 8 × 6 × 5¼in. ● All parts sold separately. Set of parts if purchased at one time **£5/19/6**, plus 8/6 P.P. and ins. Circuit diagram and instructions 1/6 post free. **Mark II Version** as above but complete with magic eye, front panel and brackets, **£6/12/6**. P. & P. 8/6. **Mark III Version** as Mark I but with output stage (ECL82) and tone control. **£7/7/-**. P. & P. 8/6. **Handsome Metal Cabinets.** Choice of Black or Green. To fit Mark I, **25/-**. P. & P. 2/6. To fit Mark II, **17/6**. P. & P. 2/6.

SPECIAL PURCHASE! TURRET TUNERS
by famous maker
Brand new and unused. Complete with PCC84 and PCF80 valves, 34-38 Mc/s. I.F. Biscuits for Channels 1 to 5 and 8 and 9. Circuit diagram supplied. **ONLY 25/-** each. P. & P. 2/6.

GÖRLER F.M. TUNER HEAD
88-100 Mc/s. 10.7 Mc/s. I.F. **15/-** P. & P. 1/9. (ECC85 valve 8/6 extra)

TAPE DECKS
B.S.R. MONARDECK (Single speed) 3¾in. per sec., simple control, uses 5¾in. spools, **£6/15/-**, plus 5/6 carr. and ins.
COLLARO STUDIO DECK. 3 motors, 3 speeds, push button control. Up to 7in. spools **£10/10/-**. P. & P. 5/6. (Tapes extra on both.)

SPECIAL OFFER!! BRAND NEW HEAVY DUTY 12 INCH SPEAKERS
Response 45 c/s.-13 kc/s. 1½in. voice coil. Available in 3 or 15 ohm. Guaranteed full 15 watts British rating. Heavy cast aluminium frame. These are current production by world famous maker and as they are offered well below list price we are not permitted to disclose the name.
LIMITED NUMBER ONLY. UNREPEATABLE AT 89/6. P. & P. 5/-.
Also 25 w. guitar model available at £5/5/-.

MATCHED PAIR OF 2½ WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS. Stock size 1½ × 1½ × ¾in. Output trans. tapped for 3 ohm and 15 ohm output. **10/-** pair, plus 2/- P. & P. Worth double.
BRAND NEW PLESSEY. 12 v. 4 pin non-sync. vibrators. Type 12 1.48D. ONLY **8/6**. P. & P. 1/6 each.
ROLA CELESTION. Approx. 9 x 6in. 3 ohm Middle register speaker, **10/6**. P. & P. 1/6.

HARVERSON SURPLUS CO. LTD.

170 HIGH ST., MERTON, S.W.19. CHErrywood 3985

Open all day Saturday Early closing Wed., 1 p.m.

A few minutes from South Wimbledon Tube Station. (*Please write clearly*)

Overseas P. & P. charged extra. S.A.E. with all enquiries.

NEW LIST OF BARGAINS

Transistor ferrite rod aerial with medium and long wave coils with circuit, **7/6**.

Oscillator Coil and set of 3 I.F. transformers for transistor set with circuit, **12/6**. **Tuning Condensor** to suit, air-spaced, with trimmers, **9/-**.

Ditto, but min. 10 mm. **12/6** the set, two-gang condensers to suit **8/6** (request sub. min. circuit).

Midget 3in. P.M. Loudspeaker, 3 ohm, **12/6**. 80 ohm, **13/6**.

Midget 208 pF + 176 pF two-gang Tuning Condenser with trimmers for transistor set. Price **9/-**.

Push-Pull Transformer. Sub-miniature, **8/6**.

.0005 mfd. Single Tuning Condenser. Solid dielectric ¼in. spindle for transistor of Crystal set, with spindle tapped 6 BA, **2/6**.

46 Sets (Receiver/Transmitter pack set). Unused sets complete except for crystals, **19/6**. Post 3/-.

Battery Charger Kit. Comprises 5 amp. transformer, 5 amp. rectifier, metal case and meter to charge 6 or 12 volt batteries up to 5 amps. With variable charge rate, **39/6** each. 3/6 ost & insurance.

Mains Transformer. 250-0-250 at 80 mA. 6.3 volts 5 a. (normal mains input), **12/6** each. Carr. 2/6.

Output Transformer. Standard pentode matching type, **4/6** each; **48/-** per doz

Slide Switch. Sub-miniature but dpdt., **2/-**; **18/-** doz.

T.C.C. or Dubilier Tubular Condensers.

.5 mf. 500 v.	**10/-** doz.
.25 mf. 500 v.	**7/6** doz.
.25 mf. 350 v.	**6/-** doz.
.05 mf. 500 v.	**5/-** doz.
.0001 mf. 1000 v.	**5/-** doz.
.001 1000 v.	**6/-** doz.
.002 1000 v.	**7/6** doz.
.005 1000 v.	**9/-** doz.
.02 750 v.	**8/6** doz.
.01 1000 v.	**10/-** doz.

Battery Charger Rectifier. Selenium 12-15 v. 5 amp. **9/6**.

Metal Chassis. Punched for Mullard 510 Amplifier complete with inner screening sections and stove enamelled. **12/6** set.

Unbreakable Mains Lead. Type of lead fitted to electric razors makes fine lead for test meters and any other devices where subject to continuous bending. Twin figure eight construction, soft cream P.V.C. covered. Normally costs **2/-** per yard. Three 6ft. leads for **2/-**.

Filament Transformers. 6.3 v., 1½ amp. **6/6**.

Neon Lamp—midget wire ended, ideal mains tester, etc. **2/-**. Ex-Govt. **1/6**.

Philips Trimmers. 0-30 pF. **1/-** each; **9/-** doz.

Heavy Duty Test Prods—red and black with plug-in lead attachments, **6/6**.

Low Resistance Headphones. Ideal crystal sets, etc. **7/6**, plus 2/6.

Cold Cathode Valve CV 413. Voltage regulator or trigger switch—unused but ex-equipment **2/-** each.

Tag Panels. Ideal for construction, experimental circuits, etc., 3 of each of 12 different types, **5/-**. Post 1/6.

Slydlock Panel Mounting Fuses, with carrier, 5 amps. **2/-**; each; 15 amp. **2/6** each.

.1 mfd. 350 v. Small tubular metal-cased condenser made by Dubulier, **2/6** doz.

Ozone Outfit—for removing smells and generally improving any oppressive atmosphere. Kit consists of Philips ozone lamps and mains unit, only needs box. **19/6**, plus 3/6 postage and insurance.

Black Light Unit. 125 watt intensity, comprises quartz lamp, adjustable lamp holder and 125 watt choke. **Only 29/6** plus 6/6 carriage and insurance.

Packard Bell Pre-Amp. Contains a relay, push-pull input and output transformers and many useful spares. Less valves **6/6** each plus 2/6 post and insurance.

Fridge Handles. With Yale type locking mechanism, two keys, and striking plate, **3/9**, plus 2/- post, 8 for **30/-**. Post free.

0-1mA. Meter, made by the American Westinghouse Co., 3in. diameter, flush mounting scale calibrated in volts, **25/-**, plus 2/- post and insurance.

Ferranti Fire Bar. 500 watt 10in. **3/6** each, plus 1/6 post. Three or more post free.

B7G Valve Holder. Best make (Amphenol) **3/-** dozen, post 1/6. 3 doz. post free.

Precision Wheatstone Bridge—opportunity occurs to build 100k. wire wound 15 watt potentiometer, price **5/-** plus 1/- postage.

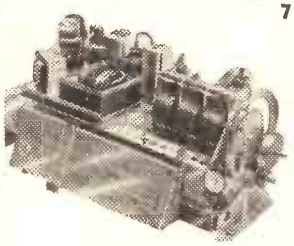
Clydon Turret Tuner. 35 mc/s. with band 1 and band 2 coils. Brand new, **9/6** each, post 2/6.

Hi-Fi Speakers

E.M.I. Ceramic magnet 12,000 lines, size 13in. × 8in. (roughly equivalent to 12in. round speaker). Base frequency 40-50 c/s. Handles up to 10 watts. Price **33/6** plus 5/- carriage and ins. State whether 15 ohm or 3 ohm.

Where postage is not definitely stated add 2/- to all orders under £3.

7 valve 5 Wave Superhet



Famous maker — has H.F. Stage and many special features—covers Medium and 4 Short bands to 11 metres—offered for less than the value of the coil pack alone. 12 volt model **39/6**, no power pack model **27/6** unused but a little dusty all less scale and drive—also less valves but there are Standard octal types 6K7, 6K8, 6Q7, 6V6, 5V4, available price **20/-** the set. DON'T MISS THIS! Carriage and insurance 7/6.

INFRA-RED BINOCULARS

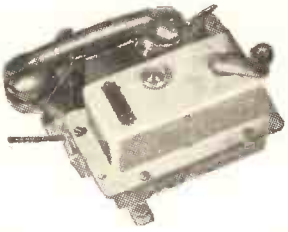
These if fed from a high voltage source will enable objects to be seen in the dark, providing the objects are in the rays of an infra-red beam. Each eye tube contains a complete optical lens system as well as the infra-red cell. These optical systems can be used as lens for T.V. camera—light cell, etc. (details supplied). The binoculars form part of the Army night driving (Tabby) equipment. They are unused and believed to be in good working order, but sold without a guarantee. Price **£2/17/6** plus 10/- carriage and insurance. Handbook 2/6.

THIS MONTH'S SNIP

GARRARD AUTO-SLIM RECORD CHANGER

One of the nicest record changers that this famous company make—Automatic selection of records which may be mixed—may also be played manually. Finger tip adjustment of Stylus pressure. Fitted with mono head—but pickup wired for stereo—suitable 200/250 A.C. mains—cabinet space required 14¼ × 12½ with 4¾in. above and 2¾in. below. DON'T MISS THIS SPECIAL SNIP, ONLY **£5/15/-**. (Post and Ins. 6/6).

EX-ROYAL NAVY SOUND-POWERED TELEPHONE



These require no batteries and will go for long periods without attention. Complete with generator and sounder which gives a high-pitched note easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or, where several telephones are used together, will indicate which one is being called. Size 7¾ × 9 × 7¼in. wall mounting, designed for ship's use but equally suitable for home, office, warehouse, factory, garage, etc. In good order but soiled. Price **29/6** each, plus 6/6 carriage.

RECORD PLAYER CABINET BARGAIN

Extremely well made and covered in two tone rexine. Will take Garrard or B.S.R. units and amplifier. **32/-**. (Regret callers only.)

750 mW TRANSISTOR AMPLIFIER

4 transistors including two in push-pull-input for crystal or magnetic microphone or pick-up—feed back loops—sensitivity 5 m/v. Price **19/6**. Post and ins. 2/6. 35 ohm speaker **12/6** extra.

MAINS POWER PACK

MAINS POWER PACK designed to operate transistor sets and amplifiers. Adjustable output 6 v.—9 to 12 volts for up to 500 mA. (class B working). Takes the place of any of the following batteries. PR1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer-rectifier, smoothing and load resistor, 5,000 and 500 mfd. condensers, zener diode and instructions. Real snip at only **14/6**, plus 2/6 post.

MAKING AN F.M. TUNER

Available, at present, is a very nice cadmium - plated F.M. Tuner chassis with holes punched for coils and other components, also a nicely printed perspex front, calibrated usual F.M. frequencies. Real bargain **6/6** plus 2/- or with two-gang tuning condenser **10/-** plus 2/- postage.

SPEAKER BARGAIN

12in. High fidelity loudspeaker, High flux permanent magnet type with either 3 or 15 ohm speech coil. Will handle up to 10 watts. Brand new, by famous maker. Price **27/6**, plus 3/6 post and insurance.

Waterproof Heater Wire

16 yd. length. 70 watts. Self regulating temperature control, **10/-** post free.

TRANSISTOR SET CASE

Very modern cream cabinet, size 5¼ × 3 × 1¾in. with chrome handle, tuning knob and scale. Price **4/6**, plus 1/6 postage.

Building a Scope?

3in. oscilloscope tube. American made type No. 3FP7, base 6.3 v. 6 amp. heater electrostatic deflection, brand new and guaranteed, with circuit diagram of scope, **15/-** each plus 2/6 post and insurance.

Fluorescent Light Kits

For pelmet lighting, etc. Kit consists of: Super silent choke; 2 chrome clips to hold tube; 2 bi-pin holders for tube and starter with a starter holder. Kit A for 80 watt tube at **27/6**. Kit B for 40 watt tube at **19/6**. Kit C for 2×2ft. 20 w. lamp **25/-**. Kit D for 1×2ft. 20 w. lamp **18/6**. Post and insurance 2/6 per Kit.

Timer Kit

Special offer of all components except metal box to make mains operated interval timer for photography, etc. **12/6** plus 2/6 post.

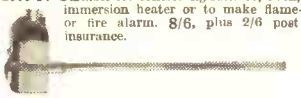
Simmerstat Heater Regulator

Suitable to control elements, heaters, soldering irons and boiling rings up to 2,500 watts. Complete adjustable, normal price 55/- each. Special snip price **12/6**, plus 1/6 postage and insurance.

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouse, airing cupboard. Has spindle for pointer knob, quickly adjustable from 30-80°F., **9/6** plus 1/- post. Suitable box for wall mounting, **5/-**. P. & P. 1/-.

Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal Screw alters the setting so this could be adjustable over 30° to 1000°F. Suitable for controlling furnace, oven, kiln, immersion heater or to make flame-start or fire alarm. **8/6**, plus 2/6 post and insurance.



Type "C" is a small porcelain thermostat as fitted to electric blankets, etc. 1½ amp. setting adjustable by screw through side. **3/6**. P. & P. 6d.

Type "D" We call this the Ice-state as it cuts in and out at around freezing point 2/3 amps. Has many uses, one of which would be to keep the loft pipes from freezing. If a length of our blanket wire (16 yds. **10/-**) is wound around the pipes, **7/6**. P. & P. 1/-.

Type "E" This is a standard refrigerator thermostat. Spindle adjustments over normal refrigerator temperature, **7/6**, plus 1/- post.

ELECTRONICS (CROYDON) LIMITED

266 LONDON ROAD, WEST CROYDON, SURREY

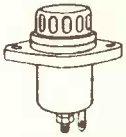
***Post orders to:* 43 SILVERDALE ROAD, EASTBOURNE, SUSSEX**

UNIQUE BARGAINS — MUST BE CLEARED

SPOT OR FOG LAMP

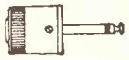
Made by Lucas, Flat or Pencil beam 36 watt. Suitable for car, boat, caravan, etc. Complete with 6 v. or 12 v. bulb, flex cables and fixing bolt. Remarkable bargain **12/6** plus 2/6 post and insurance.

LUCAS 12 v. IGNITION COIL Ex-W.D. Unused, guaranteed perfect order. Suit most cars **12/6** plus 1/6 post.



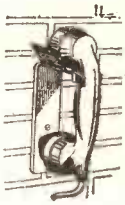
INDICATOR LAMP fitted perspex top. Takes standard screw in flash light bulb. Price **18/-** doz. Similar thing but flush, **12/-** doz.

TELEPHONE JACKS & PLUGS



Jack Plugs, bakelite, Standard size—fit most tape recorders, **4/6** doz.

SELF ENERGISED TELEPHONES



These require no batteries in fact they have only to be connected by a pair of wires. They can thus be fitted into existing bell circuits. Results are extremely good and maintenance costs are nothing. Handsets only complete as illustrated. **15/-** each, 2/6 post. Two post free.

CATHODE RAY TUBES

VCR 517	6in.	**9/6** carr. and ins.	8/6
(replaces VCR 97		new and unissued	
VCR 139A	2½in.	**27/6** carr. and ins.	4/6
VCR 138	3½in.	**27/6** ,, ,, ,,	5/6
VCR 4/1	3in.	**32/6** ,, ,, ,,	4/6
VCR 112	5in.	**27/6** ,, ,, ,,	5/6
CV 996	6in.	**22/6** ,, ,, ,,	5/6
VCR 97	6in.	**42/6** ,, ,, ,,	8/6
CV 1140	12in.	**27/6** ,, ,, ,,	12/6
CV 1590	12in.	**27/6** ,, ,, ,,	12/6

10 way Cable, ideal for interconnecting units and for remote switching circuits—each way has a flex copper core capable of carrying 5 amps and insulated to 500 v. The cable is P.V.C. covered overall. Price **1/6** per yard. 10 yards post free, otherwise add 3/6 post.

5 way Cable. Similar to 10 way, **9d.** yd., 20 yds. or more post free, otherwise add 2/6.

Twin Rubber High Current Flex. 110 strands in each core, 250 volt grade; carry a length of this in your car—if you are ever stuck with a flat battery you can join up to another car; regular price of this cable is **3/-** per yd. Our price **17/6** for 10 yds. post paid.

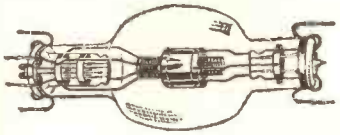
Bakelite Wall Switches. Normal household type for lighting, etc., **9/-** doz. one way or **10/-** 2 way—36 or over post free, otherwise add **2/6.**

A.C. Meter, Wall or Panel Mounting. Voltmeter 6in. dia. in metal box] for flush mounting—install one in your workshop and you will always know how the mains are. **35/-** each, 3/6 post and ins.

Blower Motor. If you are thinking of making a heater or cooler for your car or equipment, this could be the basis—intended for cooling aircraft equipment, runs O.K. off 12 volt, price **12/6** plus 2/6 post and ins.

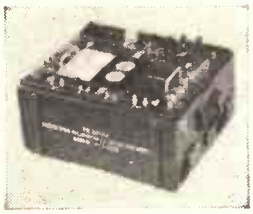
Electrical Rev. Counter. This is a dynamo with flex drive shaft. Simply take output to a voltmeter which you can calibrate in R.P.M.—beautiful instrument, must have cost a fortune, **19/6** each, post 2/6.

TETRODE TYPE VT31 TRANSMITTING VALVE

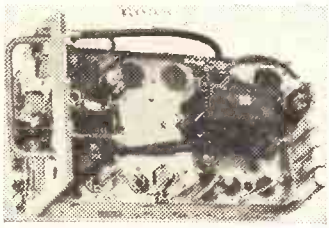


This is a high-powered air-cooled tetrode Specification of which is as follows: Heater volts 11.25, heater current 8 amp., maximum anode voltage 5 KV, anode dissipation 250 watts, size approximately 14½in. long and 6½in. across the bulb. Limited quantity only at **£1,** 4/6 P.T. each, still in original packing.

TELEPHONE REPEATER No. 1 MARK 1. This equipment is for amplifying telephone signals in both directions of traffic and also to remedy line distortion of speech. It is intended for use with two wire or four wire circuits, has four amplifiers and is in fact two quite independent repeaters mounted on the same panel and having a common power supply. The power supply may be operated from a 12-volt car battery or from standard A.C. Mains. The units are absolutely new in original packing complete with spares and instructional manual. Price **£7/10/-** each and 12/6 P. & P.

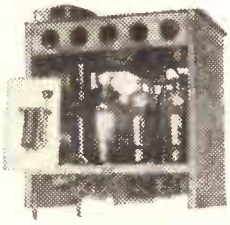


KLYSTRON RECEIVER



Partly stripped but containing valuable Klystron with tuning mechanism and a host of spares including condensers (paper and mica) transformers relay bobbins, pot meters, resistors, delay line, coils, coil formers, knobs pye sockets, trimmers, valve holders, a very useful chassis and case size approx. 15 x9 x 7½in. and hundreds of other useful sundries. Price only **9/6,** plus 7/6 carriage and packing.

BUILDING AN AMPLIFIER?



Here is a buy for you! Modulator Unit type 20. Contains parts ideal for building a large output amplifier and already set out in metal case. To name a few:—
Four high output valves Type KT44. Driver valve Type MH41. Iron cored choke for up to 200 milliamps. Dozens of wire wound and carbon resistors, paper and mica condensers. Terminals and tag panels, etc., etc. Three other items of interest to everybody and well worth the price asked for the unit are:—

1. **Transformer Reference 10K/143.** This can act as auto transformer to convert 230 to 110 or 230 to 460, and also a sa filament transformer 230 to 6.3 or 230 to 12.6 volts.
2. **Miniature Circuit Breaker.** For breaking 10 amps A.C. reset by pushing knob.
3. **Steel Case.** With heavy gauge chassis, already cut out and fitted valve holders, etc. Price for complete unit is **12/6,** carriage 7/6.

UNITS FOR CONTROLLED AUTOMATIC ROTATION

Two units work together to form a Tower rotating device, with remote control.
Item 1, known as Tower 24A, is in fact the geared driving motor which rotates the mast. This is quite a heavy construction and would rotate a heavy scanner, reflector, Beam array, etc., etc.
Item 2, known as Indicator 1-221-A is the remote controller which enables the azimuth position of Tower 24A to be controlled from a remote point. Conversely, it enables the azimuth position of the tower to be known at any time. Both the Tower and the Indicator contain selsyn transmitter/receivers and it is these that provide the impulses which cause the aerial to rotate backwards or forwards. The equipment intended for 117 volt. A.C. mains but will operate from our mains if connected through step down transformer of 1 K.W. rating.
Prices 1-221-A **£25,** TR24A **£35.**
Special discount of £5 for cash with order or C.O.D. if both units purchased together.

THE INSTRUMENT COMPANY

43 SILVERDALE ROAD, EASTBOURNE

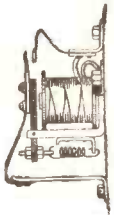
mail order only from this address — goods may be seen by appointment in Oxfordshire

CHARGING SWITCHBOARDS

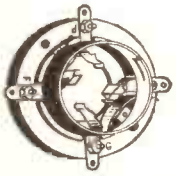
Type A, 550 w. 13 v.—contains three reverse current relays, one voltmeter rated 25 v., f.s.d., one main ammeter rate 40 amps f.s.d., one secondary ammeter rated 15 amps f.s.d., and two secondary meters rated 20 amps f.s.d., one 2 ohm variable resistor, one 11 ohm variable resistor and two 1.2 ohm variable resistors. Complete in metal case 2ft. 6in. x 2ft. 8in. approx. Price **£2/15/-,** carriage and ins. 15/-.

Type B, 1260 w. 50 v., 12 amps.—contains one 14 ohm variable resistor and four 1 ohm variable resistors, one main ammeter rated at 40 amps f.s.d., four secondary meters rated at 20 amps f.s.d., and one voltmeter rated at 50 volts, and two reverse current relays. Complete in metal case—size approximately 2ft. 6in. x 2ft. 8in. Price **£4/15/-,** carriage 15/-.

CONTACTOR

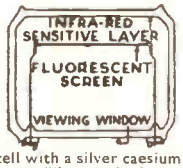


For breaking 25 amps. coil voltage is 24 v. D.C., but with a rewind or a small rectifier these will close off A.C. mains. Very heavy duty contacts. Enclosed in bakelite case. Price **2/6,** 24/- doz.



JUMBO VALVE BASES Ceramic 4 pin for transmitting valves. Price **3/6** each.

SNIPER-SCOPE



Famous war-time "cats eye" used for seeing in the dark. This is an infra-red image converter cell with a silver caesium screen which lights up (like a cathode ray tube) when the electrons released by the infra-red strike it. It follows that as light from an ordinary lamp is rich in infra-red these cells will work; burglar alarms, counting circuits, smoke detectors and the hundred and one other devices as will the simpler type of photo cell. Here then is a golden opportunity for some interesting experiments, price **5/-** each, post 1/-. Data will be supplied with cells if requested.

Spot or Fog Lamp. Made by Lucas, Flat or Pencil beam. 36 watt. Suitable for car, boat, caravan, etc. Complete with 6 or 12 v. bulb, flex, cables and fixing bolt. Remarkable bargain. **12/6** plus 2/6 post and insurance.

SLIDER RESISTORS

Heavy Duty Type. Size 7in. x 1½in. 11 ohms 4.5 amp, **22/-.** Size 9in. x 1½in. 1.2 ohms 15 amp., **15/-.** Size 13½in. x 1½in. 3 ohms 10 amp., **51/-.** 1 ohm 25 amp., **15/-.** 4 ohms 100 amp **10/-,** plus post.

R.S.C. (MANCHESTER) LTD.

Post Orders to R.S.C. (Manchester) Ltd. Dept. W, 54 Wellington St., Leeds, 1. Trade Supplied. Personal Shoppers to any of Branches below.

R.S.C. (MANCHESTER) LTD.

Post Terms. C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/9 extra on orders under £2. 4/6 extra under £5 unless carr. stated.

R.S.C. (MANCHESTER) LTD.

BRADFORD 56 Morley Street (Half day Wed.) Opening larger premises at 10 North Parade shortly.

BRISTOL 14 Lower Castle St. Tel.: 22904 (Half day Wed.)

BIRMINGHAM 30/31 Gt. Western Arcade. Tel.: CENtral 1279 New spacious premises (opp. Snow Hill Stn.) (No half day)

DERBY 26 Osmaston Rd., The Spot. Tel.: 41361 (Half day Wed.)

DARLINGTON 13 Post House, Wynd. Tel.: 68043 (Half day Wed.)

EDINBURGH 133 Leith St. Tel.: WAVerley 5766 (Half day Wed.)

GLASGOW 326 Argyle St. Tel.: CITy 4158 (No Half day)

HULL 51 Savile St. Tel.: 20505 (Half day Thurs.)

BRISTOL NOW OPEN

14, LOWER CASTLE STREET. (Half-day Wednesday)

HI-FI 10 WATT AMPLIFIERS

BRAND NEW Ex Guitar Amplifiers. **£7.19.6** Carr. 4/6

A REMARKABLE OPPORTUNITY, Push-pull output. Latest high efficiency valves. Dual separately controlled inputs for mike and gram. Separate bass and treble controls. High sensitivity. Output for 3 ohm or 15 ohm loudspeaker. Guaranteed tested and in perfect working order. For 200-250 A.C. mains.

LINEAR TAPE PRE-AMPLIFIERS Type LP/1. Switched negative feedback equalisation. Positions for Record 1⅞in., 3¾in., 7½in. and Playback. EM84 Recording Level indicator. Designed primarily as the link between Collaro Tape Transcriptor and high fidelity amplifier but suitable almost any Tape Deck. 9½ GNS. Send S.A.E. for leaflet.

TRANSISTORISED SOUND MIXER

Enables mixing of up to 4 inputs, i.e. mic, tape, gram., tuner, etc., into single output. Compact and completely self-contained, uses standard 9 v battery supplied free. Four standard jack inputs. PRICE **49/6**

R.S.C. POWER PACKS 200-250 v. A.C. Completely enclosed in louvred enamelled case. 8 × 5¼ × 2½in. Output fully smoothed 250 v. 60 mA. and 6.3 v. 2 a. **39/9**

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner (specially suitable for use with any of our Amplifiers). Triode Heptrode. F changer is used. Pentode I.F. and double Diode Second Detector. Delayed A.V.C. W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch. and Vol. Simple alignment instructions. Only 250 v. 15 mA. H.T. and L.T. or 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost of 5 GNS. Point-to-point wiring diagrams and instructions 2/6.

FANE EXTRA HEAVY DUTY LOUDSPEAKERS Total Flux 375,000 lines. Extremely high sensitivity. Exceptionally robust 3in. diameter Voice Coil assemblies. Impedance 15 ohms. Type 153 15in. 40 watts 18 GNS. or Deposit 37/9 and 12 monthly payments 31/6. (Total £20/15/9.) Type 183 60 watts 18in. 24 GNS. Or Deposit 51/- and 12 monthly payments 42/9. (Total. £28/4/-.) Send S.A.E. for leaflet.

STOCKISTS OF

ARMSTRONG CHASSIS

GOODMANS, W.B. and FANE SPEAKERS, LINEAR, LEAK, VERDIK, ROGERS, DULCI AMPLIFIERS, GARRARD and GOLDRING TURNTABLES

CASH OR TERMS

Only 3 pairs of soldered joints plus mains.

AUDIOTRINE HI-FI TAPE RECORDER KIT

Build a high quality recorder in the £70 class for only

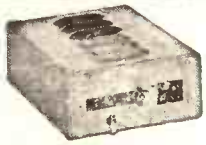
25½ GNS. Carr. 17/6

Can be assembled in 1 hour Send S.A.E. for leaflet.

OR DEPOSIT £3.0.0 and 12 monthly payments of 44/- (Total 28 Gns.) Cash price if settled in 3 months.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR THE AUDIOTRINE HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7 × 4in. LOUDSPEAKER Reel of Best Quality TAPE. Spare Tape Spool, a Portable Cabinet, size approx. 14½ × 15 × 8½in. finished in complementary shades of Rexine and Vynair. Connection diagram for wiring amplifier to transcriptor provided. FEATURES INCLUDE: ★ 3-SPEEDS ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZING FOR EACH SPEED ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR ★ 3 MOTORS ★ Fast rewind ★ TAPE MEASURING AND CALIBRATING DEVICE ★ TAKES FULL 7in. DIAMETER REELS OF TAPE ★ NEGLIGIBLE HUM ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.

R.S.C. BATTERY TO MAINS CONVERSION UNITS



Type BM1. An all-dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. Complete kit with diagram 39/9, or ready for use 46/9. Type BM2. Size 8 × 5½ × 2½in. Supplies 120 v. 90 v. and 60 v. 40 mA. and 2 v. 0.4 a. to 1 amp., fully smoothed THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2 v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions. 49/9 or ready for use 59/6.

ALL INTEREST CHARGES REFUNDED

ON H.P. & CREDIT SALE ACCOUNTS SETTLED WITHIN SIX MONTHS

R.S.C. 4 WATT GRAM. AMPLIFIER KIT

Complete set of parts to build a good quality compact unit suitable for use with any record playing unit. Mains isolated chassis. Bass and Treble controls. Output for 2-3 ohm speaker. For 200-250 v. A.C.

59/9

R.S.C. A5 4-5 Watt HIGH GAIN QUALITY AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 milli-volts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all makes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B down. 15 D.B. negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohms speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/- or assembled ready for use 25/- extra, plus 3/6 carriage. Or deposit 22/- and five monthly payments of 22/- (Total £6/12/-) for assembled unit.

R.S.C. 3 WATT GRAM AMPLIFIER KIT

All parts to build a compact, highly sensitive amplifier suitable for any single or autochange player. Size 12 × 2½ × 2½in. Double wound Mains transformer. For 200-250 v. A.C. mains. Output for 2-3 ohm speaker. Volume and tone control with switch. **39/9**

SELENIUM RECTIFIERS

L.T. Types	
2/6 v. ½ a. H.W. ..	1/9
5/12 v. ½ a. H.W. ..	2/9
Following F.W. (Bridge)	
6/12 v. 1 a.	3/11
6/12 v. 2 a.	6/11
6/12 v. 3 a.	9/9
6/12 v. 4 a.	12/3
6/12 v. 5 a.	14/6
6/12 v. 6 a.	15/6
6/12 v. 10 a.	25/9
6/12 v. 15 a.	35/9

R.T. Types H.W.	
120 v. 40 mA.	3/9
250 v. 50 mA.	3/11
250 v. 60 mA.	4/11
250 v. 80 mA.	6/11
250 v. 250 mA.	11/9
Types Below Contact cooled	
250 v. 60 mA. H.W.	5/11
250 v. 70 mA. H.W.	7/11
F.W. (Bridge) Types	
250 v. 50 mA.	8/11
250 v. 120 mA. ..	10/11

SPECIAL PURCHASE

BRAND NEW GARRARD 3000LM HIGH QUALITY

STEREO/MONO AUTOCHANGE UNITS WITH LIGHTWEIGHT PICK-UP ARM AND SPECIAL HIGH FIDELITY HEAD

NORMAL PRICE APPROX. £12.15.0

LIMITED NUMBER AVAILABLE AT **10 GNS** CARR. 5/6

ACOS GP67-2G HI-FI Crystal Cartridges with sapphire stylus. Standard replacement for Garrard, B.S.R. and Collaro. **ONLY 16/9**
ACOS Stereo/Monaural 29/6

TRANSISTOR SALE

Mullard OC71 3/9. OC45 4/11. OC44 4/11. OC72 3/11. OC81 3/11.
Ediswan XA101, XA112, XB113, XB104, XC101A. 3/9 ea. Postage 6d. for up to 3 Transistors.

JASON F.M. TUNERS Type FMT1. All parts including Dial. Escutcheon. Punched Chassis and Valves. Power supply required 180 v. 25 mA. and 6.3 v. 1.5 a.
Type FMT1 .... £6/19/6
Type FMT2 .... £8/19/9

R.S.C. BATTERY CHARGERS & KITS for 200-230-250 v. 50 c/s. A.C. Mains Guaranteed 12 mths.

HEAVY DUTY KIT

6/12 v. variable charge rate up to 6 amps. Consisting of Mains Trans. F.W. (Bridge), Selenium Rectifier, 0-7 amp. meter. Variable Charge Selector. Fuses, fuse-holders, panels, plugs and circuit. Only 59/9. Post 4/6.

TRANSFORMERS

200-230-250 v. 50 c/s.

0-9-15 v. 1½ a.	12/9
0-9-15 v. 2½ a.	14/9
0-9-15 v. 3 a.	16/9
0-9-15 v. 5 a.	19/9
0-9-15 v. 6 a.	23/9
0-9-15 v. 8 a.	28/9

BATTERY CHARGER KITS

Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grummets, panels, clips and circuit. Carr. 3/9 extra.

6 v. or 12 v. 1 amp.	22/9
As above with ammeter	28/9
6 v. 2 amps.	19/9
6 v. or 12 v. 2 amps.	25/9
6 v. or 12 v. 2 amps. (inclusive of ammeter).	35/9
6 v. or 12 v. 4 amps. with variable charge rate selector and ammeter	52/9

HEAVY DUTY 12 v. 10 AMP. KIT

Consists of Mains Transformer. F.W. (Bridged) Selenium Rectifier, Ammeter, Fuses, Variable Resistor and Circuit. For 200-250 v. A.C. mains. Only

£4-19-9 Carr. 10/-.

ASSEMBLED

6v. or 12 v. 4 amps.

Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging, fused.
Well ventilated steel case with Grey hammer finish.
Ready for use with mains and output leads. **59/9** Carr. 4/6
Or Deposit 12/- and 5 monthly payments of 12/-. (Total 72/-)
As above but for 6 amp. charging ONLY **4 Gns.** Carr. 5/-.
or Deposit 16/- and 5 monthly payments of 16/-. (Total 96/-)

SPECIAL OFFER

12 v. 2 amp. F.W. (Bridged) METAL RECTIFIERS **3 for 7/9**

FANE 122/10 20 WATT HEAVY DUTY LOUDSPEAKERS

12in. 15 ohm. With exceptionally robust 2in. diameter voice coil assembly. **5 GNS.** Post Free

EX-GOVT. SELENIUM RECTIFIERS

12 v. 15 amps. F.W. (Bridge). Only **19/9**

EX. GOVT. SMOOTHING CHOKES

60 mA. 10 h. 400 ohms 3/11. 100 mA. 10 h. 100 ohms. 6/9. 150 mA. 10 h. 100 ohms 10/11. 120 mA. 12 h. 100 ohms 9/9. 200 mA. 5-10 h. 100 ohms 11/9. 250 mA. 5 h. 50 ohms 10/9.

TANNOY 8 WATT RE-ENTRANT LOUDSPEAKERS. 8 ohms for workshop, factory or outdoor use 25/9 ea.

VALVES Full range, Keen prices. | **CHARGER AMMETERS** 0-1½ a., 0-3a., 0-7 a. **8/9**

SENSATIONAL STEREO OFFER

Complete kit of parts to construct a 3 + 3 watt good quality stereo amplifier providing realistic reproduction. Suitable all stereo pick-up leads. Ganged vol. and tone controls. Pre-set balance. For 200-250v. A.C. mains only. Fully isolated chassis. Or including Stereo Head 19/9 extra. **4 GNS.** Carr. 4/6

R.S.C. BABY ALARM or INTERCOM UNIT KIT

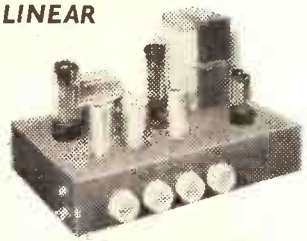
For 200-250 v. A.C. mains. Includes all parts, diagrams and instructions. High sensitivity. Completely safe. Controllable at both ends. Housed in two cabinets of pleasing design 89/6. Carr. 5/-. Or assembled and tested 6 GNS.

LEICESTER 32 High Street Tel.: 56420 (Half day Thurs.) | **LEEDS** 5-7 County (Mecca) Arcade, Briggate, Leeds 1 Tel.: 28252 (No half day) | **LIVERPOOL** 73 Dale Street Tel.: CENtral 3573 8 mins. from Lime St. Stn. (No half day) | **LONDON** 238 Edgware Rd., W.2 Tel: PADdington 1629 (Half day Thurs.) | **M'CHESTER** 60a-60b Oldham St. Tel.: CENtral 2778 (No half day) New large store | **MIDDLESBROUGH** 106 Newport Rd. Tel.: 47096 (Half day Wed.) | **SHEFFIELD** 13 Exchange Street (Castle Market Buildings) Tel.: 20716 (Half day Thurs.)

R.S.C. (MANCHESTER) LTD.

R.S.C. A10 30 WATT AMPLIFIER

HIGH FIDELITY ULTRA LINEAR PUSH-PULL OUTPUT

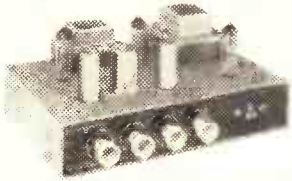


SIX VALVES EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associate vol. control is provided so that two separate inputs such as "mike" and gram. etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy to follow wiring diagram ONLY Carr. 10/- **11 Gns.** Or factory built using latest EL34 output valves and with 12 months' guarantee. **14 GNS. TERMS ON ASSEMBLED UNITS, DEPOSIT 34/6** and 9 monthly payments of 33/6 (Total 16 Gns.).
Protective Cover 19/9. Type 807 output valves are used with High Quality Sectionally Wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3.D.B. 30-20,000 c/s. Tone Controls ± 12 D.B. at 50 c/s. + 12 D.B. to − 6 D.B. at 12,000 c/s., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish gold hammer. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS, SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphone, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.**

R.S.C. A11 12-14 WATT AMPLIFIER

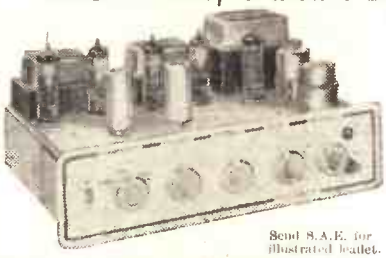
HIGH FIDELITY PUSH-PULL ULTRA LINEAR OUTPUT

"BUILT-IN" PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram. as in A.10 High sensitivity. Includes 5 valves ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation. Reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut." Frequency response ± 3 D.B. 30-30,000 c/s. Six negative feedback loops. Hum-level 60 D.B. down. **ONLY 23 millivolt INPUT** required for **FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and mikes. Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET** with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12 × 9 × 7in. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied (or factory built £10/19/6 extra). ONLY **8 Gns.** Carr. 10/-.
If required louvred metal covers with 2 carrying handles can be supplied for **18/9. TERMS ON ASSEMBLED UNITS, DEPOSIT 25/- and 9 monthly payments of 25/- (Total £12/10).** Send S.A.E. for illustrated leaflet of Cabinets, Speakers, "Mikes," etc. Cash or Terms.

R.S.C. STEREO/20 HIGH FIDELITY AMPLIFIER



Send S.A.E. for illustrated leaflet.

Providing 10-14 watts Ultra Linear Push-Pull Output on each channel.
Features include:
★ Four-position tone compensation switch.
★ Stereo/Mono switch so that peak monaural output of 28 watts can be obtained.
★ Separate bass "lift" and "cut" and treble "lift" and "cut" controls.
★ Neon panel indicator.
★ Handsome Perspex Frontplate

13 Gns. Carr. 10/- Complete set of parts with point-to-point wiring diagrams and instructions, or Factory assembled, tested and supplied with our usual 12 months' guarantee for **18 gns.**, or DEPOSIT 2 gns., and nine monthly payments of 47/6. Total **£20/15/6.**

SUITABLE for "MIKE", GRAM, RADIO OR TAPE. INTENDED FOR THE HOME OR STUDIO BUT SUITABLE FOR LARGE HALLS OR CLUBS.
Based on a current Mullard design and employing valves ECC83, ECC83, ECL86, ECL86, ECL86, ECL86, EZ81. Output transformers are high quality sectionally wound to required specification. Output matchings for 3 and 15 ohm speakers on each channel. FREQUENCY RESPONSE ± 2dB. 30-20,000 c.p.s. HUM LEVEL 65dB down. SENSITIVITY: 15 millivolts maximum. HARMONIC DISTORTION (each channel) 0.2% For operation on 200/250 v. A.C. Mains.

MANCHESTER

New large retail premises now open at 60a-60b Oldham Street.

POWER PACK KITS

Fully smoothed output 250 v. 60 mA. H.T. and L.T. 6.3 v. 1.5 amps. Consists of chassis, mains Trans. 200-250 v. Double wound, Rectifier, Choke, Electrolytics and circuit. **19/11**

FANE HIGH FIDELITY SPEAKERS

All with exceptionally robust 2in. diameter voice coil assemblies.

12in. 15 ohms. Cast chassis: HEAVY DUTY.

122/10 20 watts	5 gns.	122/10A 20 watts	6 gns.
122/12 20 watts	7 gns.	122/12A 20 watts	8 gns.
122/14 22 watts	9 gns.	122/14A 22 watts	10 gns.
122/17 25 watts	£11 17 6	122/17A 25 watts	£12 17 6

15in. 15 ohms. Cast chassis: HEAVY DUTY.

152/12 20 w.	12 gns.	152/12A 20w.	13 gns.
152/14 27w.	14 gns.	152/14A 27w	15 gns.
152/17 35w.	16 gns.	152/17A 35 w.	17 gns.

"A" indicates dual cone type 30-17,000 c.p.s. Send S.A.E. for leaflets. Terms available.

R.S.C. TRANSFORMERS

FULLY GUARANTEED

INTERLEAVED and IMPREGNATED

MAINS TRANSFORMERS. Primaries 200-250 v. 50 c/s.

FULLY SHROUDED. UPRIGHT MOUNTING.

250-0-250 v. 60 mA., 6.3 v. 2 a. 0.5-6.3 v. 2 a. 2½-3-3in.	17/11
250-0-250 v. 100 mA., 6.3 v. 4 a., 0.5-6.3 v. 3 a.	28/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 0.5-6.3 v. 3 a.	28/9
300-0-300 v. 130 mA., 6.3 v. 4 a. c.t., 6.3 v. 1 a. For Mullard 510 Amplifier	35/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0.5-6.3 v. 3 a.	29/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 0.5-6.3 v. 3 a.	37/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 5 v. 3 a.	57/9
425-0-425 v. 200 mA., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a.	59/9
450-0-450 v. 250 mA., 6.3 v. 4 a. c.t., 5 v. 3 a.	69/9

TOP SHROUDED DROP-THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2 a., 0-5-6.3 v. 2 a.	17/9
250-0-250 v. 100 mA., 6.3 v. 3.5 a.	19/9
250-0-250 v. 100 mA., 6.3 v. 2 a., 6.3 v. 1 a.	21/9
350-0-350 v. 80 mA., 6.3 v. 2 a. 0.5-6.3 v. 2 a.	19/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 0.5-6.3 v., 3 a.	27/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 0.5-6.3 v. 3 a.	27/9
300-0-300 v. 130 mA., 6.3 v. 4 a., 0.5-6.3 v. 1 a., suitable for Mullard 510 Amplifier	33/6
350-0-350 v. 100 mA., 6.3 v. 4 a., 0.5-6.3 v. 3 a.	27/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 0.5-6.3 v. 3 a.	35/9

MIDGET CLAMPED TYPE. Primaries 200-250 v.

250-0-250 v. 60 mA., 6.3 v. 2 a., 2 × 2 × 2¼in.	12/9
250 v. 60 mA., 6.3 v. 2 a. Size 2 × 2 × 2¼in.	11/9

FILAMENT TRANSFORMERS 12 v. 1 a. 7/9
6.3 v. 1.5 a. 5/9 — 6.3 v. 3 a. 8/11
6.3 v. 2 a. 7/6 — 6.3 v. 6 a. 17/9
12 v. 3 a. or 24 v. 1.5 a. 17/9

AUTO (Step UP/Step DOWN) TRANSFORMERS

50-80 watts 110-120 v./230-250 v.	13/9
150 watts 110-120 v./200-250 v.	27/9
250 watts 110-120 v./200-250 v.	49/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66.1 for 3S4, etc.	4/6
Small Pentode 5,000Ω to 3Ω	4/6
Standard Pentode 5,000Ω to 3Ω	5/9
Standard Pentode 7,000Ω to 3Ω	5/9
Push pull 8 watts EL84 to 3Ω or 15Ω	8/9
Push pull 10-12 watts 6V6 to 3Ω or 15Ω	18/9
Push pull 10-12 watts to match 6V6 to 3-5-8 or 15Ω	19/9
Push pull EL84 to 3 or 15Ω 10-12 watts	18/9
Push pull Ultra Linear for Mullard 510, etc.	29/6
Push pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15Ω	29/9
Push pull 20 watt high-quality sectionally wound, EL34, 6L6, KT66, etc., to 3 or 15Ω fully shrouded	49/9

MICROPHONE TRANSFORMERS

120-1 High quality, clamped	8/9

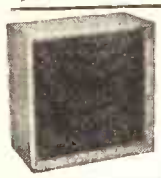
SMOOTHING CHOKES

250mA., 5 H., 100Ω	11/9	80 mA., 10 H., 350Ω	5/6
150mA., 7-10H, 250Ω	11/9	60 mA., 10 H., 400Ω	4/11
100mA., 10 H., 200Ω	8/9	1 amp. 0.5Ω L.T. type	6/6

R.S.C. STEREO/10 HIGH QUALITY AMPLIFIER

Complete kit of parts including: Valves EZ81, ECC83, ECC83, EL84, EL84. Separate bass and treble controls giving "cut" and "boost." Sensitivity 50 mV. 5 watts high quality output on each channel. Can be used as straight 10 watt amplifier. Controls: Stereo/Monaural switch ganged volume, ganged treble, ganged base and balance. Output for 3 ohms speaker. Point-to-Point wiring diagrams and instructions. Illustration full wiring details and priced parts list 1/9. Or supplied assembled and tested 59/6 extra. Carr. 7/9.
Deposit 42/- and nine monthly payments of 24/2 (Total £12/19/6)

8 GNS.



LOUDSPEAKERS IN CABINETS. 12in 10 WATT. Walnut Veneered Cabinet size 15 × 15 × 8in. approx. High quality 12in. 10 watt 12,000 line speaker, 3 ohms or 15 ohms £4/19/6. Carr. 5/-. Or Deposit 11/3 and nine monthly payments 11/3. (Total £5/12/6). **12in. 20 WATT.** High Quality 15,000 line 15 speaker 15 ohms in Cabinet finished as above. Size 18 × 18 × 8in. £7/19/6. Carr. 7/9. Or Deposit 17/9 and 9 monthly payments of 17/9. (Total £8.17.6.)

"MIKES" FULL RANGE from each **12/9**

Also Desk and Floor Stands

COLUMN SPEAKERS

For Public Address systems, vocalists etc., Rating 15-20 watts 15 ohms. Or 330 ohms for 100 v. line. Fitted five 8in. high flux speakers. Size approx. 42 × 10 × 5in.
Terms: Deposit 29/- and 9 monthly payments of 29/- (Total £14.10.0).

12½ GNS. Carr. 10/-

100 v. line version 35/- extra.

R.S.C. STANDARD BASS REFLEX CABINET. For 12in. Loudspeakers. Acoustically lined and ported. Size 20in. × 14in. × 13in. Beautiful walnut veneer finish. Especially recommended for use with Audiotrine Speaker System. £5/19/6. Set of four legs can be supplied with brass ferrules for 19/6.
AUDIOTRINE CORNER CONSOLE CABINETS. Strongly made. Beautiful polished walnut veneered finish. Pleasing design.
JUNIOR MODEL. To take up to 8in. speaker. Size approx. 20in. × 11in. × 8in. Only 49/9.
STANDARD MODEL. To take up to 10in. speaker. Size 27in. × 18 in. × 18in. £4/11/9.
SENIOR MODELS. To take up to 12in. speaker and with Tweeter cut-out. Size approx. 30in. × 15in. × 15in. (Recommended for use with Audiotrine speaker system). 7 Gns. or terms.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS HF1012. 10 watts rating. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/12/-. Please state whether 3 ohm or 15 ohm required.

AUDIOTRINE HIGH FIDELITY SPEAKER SYSTEMS

Designed to provide a smooth frequency response from 40-20,000 c.p.s. consisting of 12in. 12,000 line 15 ohm speaker. Crossover Unit and Tweeter. Highly recommended for use with any High Fidelity Amplifier. **10 Watt Unit £4/19/6** or Deposit 11/3 and nine monthly payments of 11/3. (Total £5/12/6.) **20 Watt Unit £6/19/9** or Deposit 15/9 and nine monthly payments of 15/9. (Total £7/17/6).

GL3A MINIATURE 3-WATT GRAM. AMPLIFIERS. For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11¾ × 2½ × 2½in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changer unit. Output for 2-3 ohm speaker. Only **59/6**

R.S.C. JUNIOR BASS REFLEX CABINET. Designed for above speaker, but suitable for any good quality 8in. or 10in. speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18in. × 12in. × 10in. Strongly made. Handsome appearance. Ensures superb reproduction for only £3/19/6. Deposit 9/6 and 9 monthly payments of 9/6. (Total £4/15/-.)

HEAVY DUTY L.T. TRANSFORMERS

All primaries 220-240 volts. Terminal block connections.

No.	Sec.	Taps	Price	Carr.
1	25 30 35 v. 40 a.		£11 19 6	10/–
2	25 30 35 v. 20 a.		£6 19 6	7/6
3	25 30 35 v. 10 a.		£4 15 0	5/–
4	25 30 35 v. 2 a.		£1 17 6	3/6
5	10 17 18 v. 10 a.		£2 17 6	4/–
6	24 volts 30 amps.		£7 15 0	7/6
7	20 volts 30 amps.		£6 15 0	7/6
8	50 volts, 15 amps.		£6 19 6	7/6
9	30, 40, 50 v., 5 a.		£4 15 0	5/–
10	25, 36, 48 v., 8 a.		£4 19 6	5/–
11	17, 18, 20 v., 20 a.		£4 19 6	5/–
12	6, 12 v., 20 a.		£3 12 6	5/6
13	20 v., 20 a.		£4 15 0	7/6
14	30, 32, 34, 36 v., 5 a.		£2 17 6	4/–
15	6, 12 v., 10 a.		£2 2 6	4/–
16	12 v., 5 a.		£1 9 6	3/–
17	24 v., 10 a.		£3 5 0	4/–
18	24 v., 5 a.		£1 19 6	3/6
19	48, 56, 60 v., 1 a.		£1 9 6	3/6
20	12, 24, 30, 48 v., 2 a.		£2 5 0	3/6
21	6.3 v., 15 a.		£1 17 6	3/6
23	12, 24 v., 1 a.		15 0	2/6
24	9, 15 v., 2 a.		17 6	2/6
25	6, 9, 15 v., 4 a.		£1 5 0	3/6
26	12, 18 v., 10 a.		£2 12 7	4/–
27	12, 18 v., 20 a.		£3 19 6	5/–
28	10, 18, 20 v., 9 a.		£3 9 6	5/–
29	15 v., ct., 5 a.		£1 5 0	3/6
30	10, 11, 12 v., 1½ a.		10 6	2/–

Multi-tapped TRANSFORMERS

Pri. T. 200-250 v. Sec. T. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30 v. 5 amps., **47/6.** P.P. 4/-. 4 amps. **39/6,** P.P. 3/6. 2 amps. **25/-.** P.P. 3/-.

AUTO TRANSFORMERS

240 v.-110 v. Completely Shrouded fitted with 2 Two-Pin American Sockets or Terminal Blocks. Please state which type required. 1,000 watts. **£4/15/-.** carr. 5/-. 500 watts, **£3/10/-,** carr. 4/-. 300 watts, **47/6,** P.P. 3/6. 150 watts, **37/6,** P.P. 3/-. 60 watts, **29/6,** P.P. 2/6. **2,000 watts.** Completely enclosed in metal case. Size 10 x 8 x 6in. Fitted with 2 American Sockets or Terminal Blocks, **£9/15/-.** Carr. 7/6.

Samson's Electronics Ltd.

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We have London's largest selection of Low Tension Transformers, Variable Voltage Transformers, Smoothing Chokes, Capacitors, Sliding Resistors, Low Tension D.C. Supply Units. Send for lists.

SPECIAL OFFER OF BRAND NEW ERNEST TURNER 2½in. ROUND FLUSH PANEL D.C. INSTRUMENTS.

50-0-50 microamps **50/-.** 0-50 microamps **45/-.** 0-200 microamps **30/-.** 0-500 microamps **25/-** 0-50 milliamps **19/6.** 0-10 v. **15/-.** 0-20 v. **15/-.** 0-200 **17/6.** 0-500 v. **22/6.** Ediswan 3in. square instruments flush D.C. 0-50 mA. **19/6.** 0-250 v. **22/6.** Rectified A.C. 0-8 amps. **19/6.** 2½in. round dual purpose 200 mA. and 75 mA. or 100 mA. 75 v. with res. box **22/6.** Please add 2/6 P.P. on all meters.

RE-ENTRANT LOUD HAILERS

15 ohm, 20 watt, dia. 15 in. Complete with mounting bracket. Brand new **£8/19/6.** Carr. 10/-

SPECIAL OFFER OF BRAND NEW CAPACITORS

4 mfd. 800v. wkg. at 180 deg. F. **3/9,** P.P. 2/-. 5 mfd. 400 v. a.c. wkg. 400 cycles **4/9,** P.P. 2/-. 5.25 mfd. 660 v. a.c. wkg. 50 cycles **6/6,** P.P. 2/-. All by famous makers.

L.F. CHOKES BY FAMOUS MAKERS.

20 H. 30 mA. 200Ω, **17/6.** P.P. 5/-. 20H. 250 mA 250Ω, **15/-,** P.P. 4/6. 15H. 250 mA. 130Ω, Sealed "C" Core, **17/6,** P.P. 5/-. 10H. 250 mA. 124Ω, "C" Core, **12/6,** P.P. 3/-. 10H. 75 mA. 400Ω Sealed "C" Core, **7/6,** P.P. 2/6. 1H 240 mA. 35Ω, Sealed, **7/6.** P.P. 2/6.

WODEN A.C. CHOKES

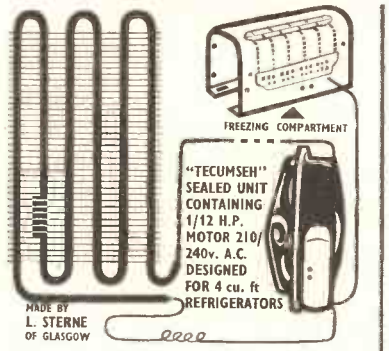
To pass 100 Amps at 220 v. Base size 6 x 5. Height 4in. Weight 18 lbs. Supplied Brand New in Maker's cartons, **45/-.** Carr. 7/6.

IBM DOUBLE WOUND TRANSFORMERS

Pri. Tapped 220, 220, 240 v. Sec. Tapped, 110-100 v., 200V. A. **47/6,** Carr. 5/-. Tropically rated.

REFRIGERATION SEALED UNITS

BRAND NEW!



These units are ideal as replacement units, refrigeration cupboards and cold stores, ice making, etc. Type P1219 sizes, unit 10 x 10 x 5ins. Freezer 12 x 6½ x 5ins. Condenser 19 x 2ins.

Complete in Original Packing P. & P. 10/-. **£8.10.0**

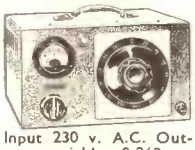
THERMOSTATIC CONTROL for above **15/-.**
If Sold Separately, P. & P. 1/6

STC INTER-COM. TELEPHONES. Latest type. All components, Buzzer and Battery housed in beautifully made Hand Set. Size 9 x 2½ x 2½in. Effective communication up to 60 miles. Supplied brand new, **£9/12/-** per pair. P.P. 4/-. Further particulars sent on request.

NO EXCUSES! NO DELAYS! FROM STOCK!

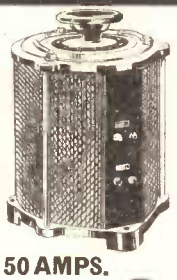
VARIABLE VOLTAGE TRANSFORMERS

PORTABLE



Input 230 v. A.C. Output variable 0-260 v. A.C. at 2.5 v. Fitted in beautifully finished steel case. Complete with voltmeter, pilot lamp, fuse, switch, carrying handle, **£9/17/6** P.&C.5/-.

50 AMPS.



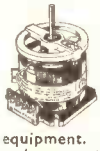
1 AMP.

INPUT 230 v. A.C. 50/60~
BRAND NEW. Carriage Paid. Buy direct from the importer, keenest prices in the country. All Types (and Spares) from ½ to 50 amp. available from stock.

0-260 v. at ½ amp.	£3 3 0
*0-260 v. at 1 amp.	£4 10 0
*0-260 v. at 2.5 amps.	£5 17 6
2.5 amps., Portable	£9 17 6
*0-260 v. at 4 amps.	£8 7 6
*0-260 v. at 5 amps.	£9 0 0
*0-260 v. at 8 amps.	£13 10 0
*0-260 v. at 10 amps.	£17 0 0
*0-260 v. at 12 amps.	£19 10 0
*0-260 v. at 20 amps.	£32 10 0
*0-260 v. at 37.5 amps.	£65 0 0
*0-260 v. at 50 amps.	£85 0 0

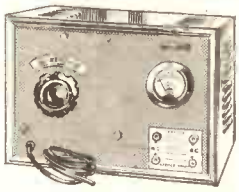
***These instruments are fully shrouded.**

1 AMP. OPEN TYPE.



(Type IA) Compact well constructed unit designed for building into equipment. Panel or rack mounting, extending shaft. Complete with engraved voltage panel and control knob. Input 250 v. A.C. Output variable 0-260 v. Ideally suited for Manufacturers of variable voltage equipment. Price **£4/17/6** post paid.

7 AMP. A.C./D.C. VARIABLE OUTPUT POWER UNIT



Input 230 v. A.C. Output continuously VARIABLE from 0 to 260 v. A.C. OR 0 to 230 v. D.C. at 7 a. Robustly constructed in metal case, complete with safety fuse, neon indicator and voltmeter. Size 17 x 12 x 7in. Weight 36lb. Price **£34/10/-.** Carriage 20/-.

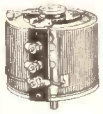
INSULATED TERMINALS available in black, red, white, yellow, blue and green. New, **15/-** per doz. P. & P. 1/-.

100 WATT POWER RHEOSTATS (NEW)

Ceramic construction winding embeddded in Vitreous Enamel heavy duty brush assembly designed for continuous duty.

Available in the following four values.
50 ohm. 1.4 a., 100 ohm. 1 a., 1,000 ohm., 280 mA., 1,500 ohm. 230 mA. Dia. 3¼in. Shaft length ⅞in., dia. 1/8in., **27/6.** P. & P. 1/6.

NEW ½ AMP. FULL RANGE VARIABLE VOLTAGE TRANSFORMER

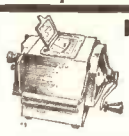


Input 230 v. A.C. Output continuously variable from 0 to 260 v. at ½ amp. Size: dia. 3in., depth 3½in. including shaft, single hole fixing. Easily built into equipment. Ideal for manufacturers or Lab. use. **£3/3/0.**

SLIDER RESISTANCES

1 ohm., 12 amp., **17/6;** 1.2 ohm, 14 amp. **27/6;** 75 ohm, 2 amp. **37/6;** 200 ohm, 1.25 amp. **37/6;** 36 ohm, 6.5 to 2.8 amp., tapered winding, geared drive (less knob), **37/6.** P. & P. 3/6.

INSULATION TESTERS (NEW)



Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size: L. 8in., W. 4in., H. 6in. Weight 6lb. 500 volt, 500 megohms. Price **£22,** carriage paid. 1,000 volts, 1,000 megohms, **£28,** carriage paid.

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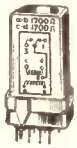
ULTRA VIOLET BULBS

Easy to use source of U.V. for dozens of practical and experimental uses.
12 volt 36 watt A.C./D.C. SBC **6/6.** P. & P. 1/-.
12 volt 60 watt A.C./D.C. SBC **8/6.** P. & P. 1/-.
Transformer to suit the above. Input 200-240 v. A.C., 12 volt 36 watts, **16/6**; P. & P. 2/6. Input 200-240 v. A.C. 12 volt 60 watt, **22/6.** P. & P. 3/6.
Set of 4 Colours FLUORESCENT PAINT. Red, yellow, green and cerise. In ½ oz. tins. Ideal for use with the above Ultra Violet Bulbs. **9/6,** plus 1/6 P. & P.

SIEMENS SEALED HIGH SPEED RELAYS



H96A, 2.2 ohm + 2.2 ohm., new **12/6.**
H96B, 50 ohm + 50 ohm, new **12/6.**
H96C, 145 ohm + 145 ohm, new **12/6.**
H96D, 500 ohm + 500 ohm, new **12/6.**
H96F, 1,000 + 1,000 ohm, new **12/6.**
H96E, 1,700 ohm + 1,700 ohm, ex. equip., **16/6.** P. & P. 1/- on each Relay.

CARPENTER'S POLARISED RELAY

Type 5A57, 65 ohm coil will operate on less than .5 of a volt. **22/6.** P. & P. 1/-.
Bases for Carpenter Relay. New, **3/6** each.

P.O. RELAYS, Type 3,000

200 ohm, 6 c/o. 6,500 ohm, 1 c/o, 1 break.
500 ohm, 6 c/o. 16,000 ohm, 2 make, 2 break.
500 ohm, 4 Heavy Duty Make.
2,000 ohm, 4 make, 4 break.
All at **12/6** each, plus 1/- P. & P.

G.E.C. SEALED RELAYS

M1069 5,000 ohm, 2 c/o. M1084 180 ohm, 4 c/o.
M1092 670 ohm, 4 c/o. M1095 670 ohm, 2 m. 2 b.
M1100 670 ohm, 2 c/o. Ex new equipment.
All at **12/6** each plus 1/- P. & P.

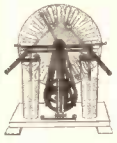
7,000 OHM SEALED RELAY. High Speed single c/o. Platinum contacts. Super-sensitive, ideal for Transistor circuitry. Will operate on 1 milliamp. **25/-.** P. & P. 1/-.

SPECIAL REVERSING 24 VOLT D.C. MOTOR 2-AMPERE
Quadrant moves 90 degrees with limit switches. Ideal for opening doors, etc. Price **32/6** P. & P. 3/-.

SOLENOID. Overall length 3⅛in., stroke ¼in. to ¼in. Maximum push 8 oz. 12-24 v. D.C. operation. D.C. resistance 35 ohm. Price **8/6.** P. & P. 1/6.
SOLENOID Heavy Duty 230 v. A.C. Approx. 3lb. pull. **15/-.** P. & P. 1/6.
SOLENOID OPERATED MAGNETIC RELAY. Type Sc/3944, 4 Pole c/o., 10 amp. Contacts, 24 volt D.C. operation, **12/6** each. P. & P. 1/6.

SX 631 SILICON RECTIFIER. 100 v. PIV. 750 mA in air or 2 amp. on 2×2 ali. heat sink, **3/6** each, P. & P. 6d., or 4 to make bridge **12/-**, P. & P. 1/-.

WIMSHURST ELECTROSTATIC GENERATORS



Really well constructed machine. Ideal for School and Laboratory to demonstrate the various effects associated with static energy. Will work well in any atmospheric condition giving a spark over 3in. long in dry weather. 11in. dia. twin plates. 2 Leyden jars. Discharge electrodes. Heavily plated fittings, mounted on solid wooden base. Outstanding value at **£13/17/6.** Carriage U.K. (B.R.S.) 10/-.

RESETTABLE HIGH SPEED COUNTER. 3 figure, 1,500 ohm coil, 40-50 v. D.C. operation. Brand new, **50/-** each, plus 1/6 P. & P.
EX P.O. MAGNETIC COUNTER (old type), either 500 ohms for 24 volt operation or 3 ohms for 6 volt D.C. operation. 4 figures to 9,999. Price, either type, **8/6.** P. & P. 1/6.
LATEST HIGH SPEED MAGNETIC COUNTERS. 4 figure, 10 impulses per second. Type 100D, 4.1 ohm coil, 3-6 v. D.C. operation. Type 100A, 500 ohm coil, 18-24 v. D.C. operation. Type 100B, 2,300 ohm coil, 36-48 v. D.C. operation. Any type **15/-** each, plus 1/6 P. & P.

DIALS FOR AUTOMATIC TELEPHONES, used but good condition, **12/6** ea., plus 2/6 P. & P.

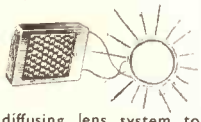
CROMPTON PARKINSON BRAND NEW ¼ h.p. MOTORS. 230/250 VOLT A.C. 1,400 R.P.M. Fitted with 2½ x ½in. SPINDLE. **Price £3/5/-.** Carriage 8/6.

HIGH SPEED BLOWER UNIT

200/250 volt A.C. Powerful 2-speed motor, 11,000 and 13,000 R.P.M. **17/6,** plus P. & P. 2/6.
AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type **£2/6/6** each. P. & P. 2/6. 500 watt type **£3/7/6** each. P. & P. 3/9. 1,000 watt type **£4/10/-** each. P. & P. 6/6.

FIRST AGAIN!

TYPE 34R SILICON SOLAR CELL



Four .5 volt units series connected in high impact polystyrene case, flying lead connections. Specially designed diffusing lens system to ensure maximum light pick-up. Output—up to 2 v. at 16—20 mA. in bright sunlight. Wider spectral response, and thirty times the efficiency of selenium cells. As used to power earth satellites! **37/6,** and 1/- P. & P.

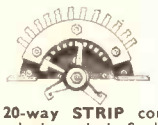
230 v. A.C. RELAY. Type 1. 2 c/o, 2 amp. contacts, **9/6.** Type 2. 2×15 amp. break. 2×2 amp. make, 1×2 amp. break. **11/6.** Both types ex new equip. P. & P. 1/6 each.

230 VOLT A.C. GEARED MOTORS

Type B16G 80 r.p.m. 26lb. inch £2/2/-. P. & P.2/-.
Type D16G 5 r.p.m. 1.7b. inch £2/9/6. P. & P. 2/6.
Type D16G 13 r.p.m. 1.45lb. inch £2/12/6. P.&P. 2/6.

230 Volt AC 50 c/s. 5-figure Veeder-Root Counter (not resettable) New. Boxed. **19/6,** plus 2/6 P. & P.

MINIATURE UNISELECTOR SWITCH



3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36 v. operation. Ex equip. individually tested. **22/6,** plus 2/6 P. & P.

20-way STRIP containing standard Post Office telephone Jack, Sockets, overall size 11 x 3½ x ½in. New. Price **15/-** each. P. & P. 1/6.

LIGHT SENSITIVE SWITCH

Kit and parts including ORP.12 Cadmium Sulphide Photocell, Relay, Transistor and Circuit. Now supplied with new Siemens High Speed Relay for 6 or 12 volt operation. **Price 25/-,** plus 2/6 P. & P.
ORP.12 and Circuit 8/6, post paid.

SEMI-AUTOMATIC "BUG" SUPER SPEED MORSE KEY.

7 adjustments, precision tooled, speed adjustable, 10 w.p.m., to as high as desired. Weight 2½ lb. Price **£4/12/6,** post paid.

KEYING LEVER

Especially designed for use with all types of electronic keyers. Fully adjustable micro-switch action, no contact bounce, precision made, finely polished parts. Screw down base. Price **£4/4/-,** post paid.
TRANSISTORISED FULLY AUTOMATIC ELECTRONIC KEYER. 230 v. A.C. or Battery operated. Incorporates built-in monitor Oscillator, Speaker, and Keying Lever. Adjustable speeds. Keying either auto., semi-auto. or hold. 4 diodes. 7 transistors. Price. **£16/10/-,** plus 4/6 P. & P.

TRANSISTORISED MORSE OSCILLATOR Fitted 2½in. Moving Coil Speaker. Uses type PP3 or equiv. 9 v. battery. Complete with latest design Morse Key, **22/6,** plus 1/6 P. & P.
BOMBSHIGHT COMPUTER, Type T.I.A. Contains hundreds in precision gears plus infinitely variable resolving gears, worm drives, ½° repeater motor, 4 aneroid barometers, D.C. motors, gyro unit, rev. counters, etc. As new, **£3/12/6** plus 7/6 carriage (rail).

TRANSISTORS

1st grade						Brand new	
OC28	17/-	OC83*	6/-	2N458		20/-	
OC29*	18/-	OC139	12/-	2S019		30/-	
OC41	7/-	OC140	19/-	SB345		7/6	
OC44	6/6	OC171	9/-	TK20B		4/-	
OC45	5/-	OC200	10/6	AC107		14/6	
OC71	5/-	OC203	13/-	AF114		11/-	
OC72*	7/-	Get 104	6/-	AF115		10/-	
OC73	6/-	Get 105	10/-	AF116		10/-	
OC75	7/-	Get 573	12/6	AF117		9/6	
OC76	6/-	2N706A	17/6	BCZ11		10/-	
OC81*	8/-						

*Available in Matched Pairs.

DIODES

OA91	3/-	1S111	4/-
SX781	4/-	ZS10B	3/-

ZENERS 5%

All ¼ watt 5% at **10/-** each, 4.3 v., 4.7 v., 5.1 v., 5.6 v., 6.2 v., 6.8 v., 7.5 v. 8.2 v., 9.1 v., 10 v., 12 v., 15 v., 16 v., 22 v.

HEAVY DUTY L.T. TRANSFORMER

Very conservatively rated for continuous duty. Input 110-260 volts, multi-tapped, 50 cycles, single phase. Output 28, 29, 30, 31 volts at 21 amp. Price **£6/15/-.** Carr. 10/-.

L.T. TRANSFORMER

Type 1. Pri. 200-240 sec. tapped 30, 32, 34, 36 volt at 5 amp., **57/6.** P. & P. 4/-.
Type 2. Pri. 240 sec. tapped 30, 40 and 50 volt at 5 amp., **£4/15/-.** P. & P. 4/-.
Type 3. Pri. 200-240 sec. tapped 10, 17 and 18 volt at 10 amp., **57/6.** P. & P. 4/-.
Type 4. Pri. 240 sec. tapped 6 and 12 volt at 20 amp., **72/6.** P. & P. 5/-.
Type 5. 17, 18, 20V. at 20 amp., **£4/19/6.** 5/- P.& P.
Type 6. 6, 12v. at 20 amp., **£4/15/-** P. & P. 7/6.

A.C. AMMETERS

0-1, 0-5, 0-10, 0-15, 0-20 amp. F.R. 2½in. dia. All at **21/-** each.

A.C. VOLTMETERS

0–200 v. A.C. Rect. M-Coil 3½in. Type W23	45/-
0–300 v. A.C. M.I. 2½in. F.L.	22/6
0–300 v. A.C. Rect. M-Coil 2½in.	29/-
0–300 v. A.C. Rect. M-Coil 3½in. Type W23	55/-

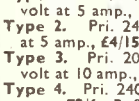
D.C. AMMETERS

0–20 amp. D.C. M-Coil 2in. Rnd.	12/6
0–40 amp. D.C. M-Coil 2in. Rnd.	12/6
0–5 amp. D.C. M.I. 2½in. Rnd.	11/6
0–500 Microamp. sub-min. 1½in. dia. Scaled 0–1 milliamp.	21/-

Postage extra.

TAPLIN GEARED MOTOR. 4½ volt D.C., 80 r.p.m., small and extremely powerful **12/6** P. & P. 2/-

DELCO 12-27 VOLT D.C. SHUNT WOUND MOTOR. 5,400 r.p.m. Torque 4in. oz. double spindle, smooth running ex-new equip. **12/6** P. & P. 2/6.



VAN DE GRAAFF ELECTROSTATIC GENERATOR, fitted with motor drive for 230 v. A.C. giving a potential of approx. 50,000 volts. Supplied absolutely complete, including accessories for carrying out a number of interesting experiments, and full instructions. This instrument is completely safe, and ideally suited for School demonstrations. Price **£6/6/-** plus 4/- P. & P. *Leaflet on request.*

4 DIAL DECADE RESISTANCE BOX

Range 0-11, 110 ohm, X1 Wire Wound, Max. current 300 mA. X10 Wire Wound. Max. current 150 mA. X100, X 1,000 High Stability Resistors, rated 1 watt Accuracy ±1%. Switches, make before break type, fitted with low resistance silver plated contacts, polished wood case, new, price **£10/10/-,** plus 6/6 P. & P.

BUILD AN EFFICIENT STROBE UNIT FOR ONLY "37/6"

The ideal instrument for workshop, lab. or factory. This wonderful device enables you to "freeze" motion and examine moving parts as if stationary. We supply a simple circuit diagram and all electrical parts, including the NSP2 Strobe tube which will enable you to easily and quickly construct a unit for infinite variety of speeds, from 1 flash in several seconds to several thousands per minute. New, modified circuits bring price down to **37/6,** plus 3/- P. & P.
NSP2 CV2296 STROBOTRON FLASH TUBE made by Ferranti, brand new, I.O. base. Price **15/-.** P. & P. 1/-.

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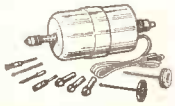
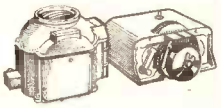
MINIDRILLS
Precision tools for miniature electronic work



Superb miniature Electric Drill Kits offered at much less than half manufacturer's selling price. Designed to fit requirements of model and toy making, jewellery, dental, optical and camera repairing, radio and electronic building, miniature drilling and polishing. British manufacture but utilising the pick of world famous German and Japanese motors. Brand new in manufacturer's cartons and complete with 5 drilling, polishing and grinding tools and full instructions.

Type 6: Compact unit fitted with powerful motor and totally enclosed in white plastic casing, size only 3¼in. long × 1⅞in. diameter overall. Complete with pin chuck, press switch and 5ft connecting lead plus 5 tools. Works from any 4½-12v. battery, **25/-**. P. & P. 2/-. **Type 8:** Identical in appearance to Type 6, but fitted with more powerful motor and supplied with two additional chuck collets to accept larger size tool shanks. Works from any 4½-13½v. D.C. supply, **35/-**, P. & P. 2/-. **Kit for mains operated power pack 25/- extra.**

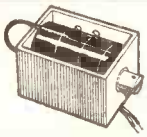
D.C. GYRO AND SERVO MOTOR—C1



Beautifully engineered Minneapolis-Honeywell precision gyro, totally enclosed in sealed light-alloy housing about 8¼in. cube. Automatic erection and precession correction. Large diameter Desynn type transmitting potentiometers provide signals corresponding to the magnitude of the deviation of gimbal arms. Powerful D.C. servo motor coupled through a differential reduction gear to a 4in. spur driving gear integral with a 3 in. diam. spiral groove cable driving drum. Two magnetic solenoid clutches and corresponding brakes hold drum rigidly in position or set free for "neutral". Nominally for 26-volt operation, but operates at 12 volts. Size 10in. × 6in. × 8in.

£10 each unit or £17/10/0 pair *Carriage 10/-*

STANDARD SOLENOIDS



Specially made, high grade Solenoid, in four basic frame sizes and for 12 v. D.C. or 240 v. A.C. pull or push operation. State requirements.

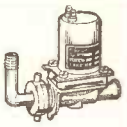
TYPICAL UNITS TYPE 1. Max. pull 9 oz. Stroke ⅛in. to ⅜in. Size 2in. long. Bolt dia. 7/16in. **12/6** *Post and Packing 1/-.*

TYPE 2. Max. pull 18 oz. Stroke ⅛in. to ½in. Size 2 9/16in. Send for list. **14/6** *Post and Packing 1/-*

TYPE 3. Max. pull 26 oz. Stroke ⅛in. to ⅞in. Size: 2 11/16in. long (bolt in) × 1 9/16in. wide × 1in. high. Bolt dia. ¼in. **27/6** *P. & P. 1/6*

TYPE 4. Max. pull 26 oz. Stroke ⅜in. to 1¼in. Size: 3 3/16in. long (bolt in) × 1 9/16in. wide × 1 13/16in. high. Bolt dia. ¼in. **32/6** *P. & P. 1/6*

MAINS OPERATED WATER COCK
Provides instant, remote flow control



Superbly engineered, solenoid actuated flow control valve for standard 200/250 volts, 50 cycles A.C. mains operation. Solenoid is contained in insulated cylindrical housing and completely isolated from valve mechanism by rubber diaphragm. Valve base is heavy cast brass, having plain tube outlet and fitted with debris filter and rotatable, angled inlet pipe. Unit makes an excellent ready-made device to use as a basis for automatic watering and humidity controls, flow measurement dispensing and automatic washing machines, remote operated taps, etc. Size overall 4½in. × 1⅞in. × 3⅛in. high. Fitted ⅜in. O.D. inlet and outlet. **Brand new. Fully guaranteed.**

15/- *Post & Packing 2/6*

ELECTRIC WATER PUMP
30/- *P. & P. 2/6*

Uses A.C. Mains Supply, Works Fountains, Empties Tanks

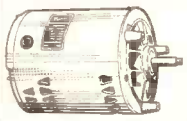
Compact, combined unit of efficient centrifugal pump and powerful induction motor operating from standard 200/250 50 c/s. AC mains. Pump has non-corrodible metal casings and neoprene impeller directly coupled to motor spindle. Motor is sturdily constructed with lifetime greased bronze bearings in rigid diecast frames. Originally intended as self-contained emptying systems for expensive washing machines and spin driers, but ideal for fountains, tank draining, lathe suds pumps, etc. Can be entirely dismantled and reassembled for cleaning and repair in minutes. Size overall 4⅝in. × 2¾in. × 3⅛in. high. Inlet 1¼in. O.D. Outlet ⅜in. O.D., New and guaranteed.

MINIATURE MAINS INDICATOR LIGHTS

Give positive indication that equipment, tools instruments, apparatus, etc., is switched on. Complete assembly of neon, resistor, insulation and flying leads that requires only connection to switch. Small size and insulation permit simple fitting; just drill small hole in panel or tape or clip to equipment. Current consumption negligible. New manufacture.

4 for 5/- *post free*

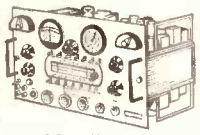
FULL ¼-H.P. MAINS MOTORS
Continuously rated, silent running



Famous make Newman motors with fantastic starting torque and giving full ¼-h.p. output. Can be readily installed for vertical or horizontal operation and will make an excellent drive unit for bench saws, compressors, potters wheels, lathes, planes, lawn mowers, and other light machinery. Heavy welded steel construction with robust diecast end frames and conforming to B.S.170. Smooth, silent operation with output speed of 1,425 r.p.m. automatically regulated by centrifugal switch. Size overall 6in. dia. × 8⅞in. long plus ⅝in. dia. × 1⅜in. long plain driving spindle with threaded end. Flange mounting is to 3 equally spaced lugs with mounting holes pitched on 5¼in. dia. circle. **For 230/250 volts, 50 cycles A.C. mains. Consumption 2½ amps. Excellent, never used condition. Fully guaranteed. Offered at a fraction of cost.**

65/- *Carriage 7/6*

COMPUTER TEST SET
£12 *Carr. £1*

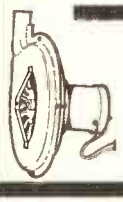


Three-part hinged chassis containing enormous quantity of expensive components, including 400 c/s. frequency standard, 50-0-50 microamp meter, 1/100 sec. timer (large sweep hand traverses 3in. dial once per second), geared drum drive, 4⅜in. × 1⅛in. escutcheon carrying 80in. of paper dial that can be readily replaced, 16 multi-contact key switches, 40 modern B9G valves with screened holders plus 2x5U4, 2 precision resolvers, helipot with vernier drive, motorised potentiometer, many vacuum sealed relays, 2 × 7 pin and 2 × 40 pin multiplugs and sockets plus a wealth of Vitamin Q condensers, precision resistors, switches, indicator lights, fuse holders, selenium diodes and other parts. Power pack with C-Core transformer operated from 115 volts 50-1000 c/s. Chassis size 17in. × 15in. high. × 15in. deep. Breakdown price.

RADAR ANTENNA ASSEMBLY
£12/10/0 *Carr. £1*

Ultra-modern, superbly engineered units made for American Jet Aircraft by Hughes Aircraft Corp. 19½in. dia. bowl is pivoted on ball-bearing die-cast gimbal brackets mounted on heavy cast base and will rotate to any position within 180° solid angle. Antenna is waveguide fed through size 16 flange fitting, otherwise assembly contains a wealth of gears, controller motors, 400 c/s. servo motors and other items. Size overall 20½in. × 17½in. × 21in. high.

6-12 volt BLOWER UNIT
25/- *P. & P. 2/6*



Self-contained assembly of compact, continuously rated motor and encased centrifugal fan. Smooth, silent running and providing a powerful blast of air from 1in. outlet pipe. Ideal for use with car heating and conditioning systems or to provide local cooling of hot running equipment and machinery. Operates from 6 volts D.C. (2 in series work on 12 volts) but can also be operated from 12 volts with 2 ohms 20 W resistor. Size overall: MOTOR, 2½in. diam × 2⅜in. long; FAN 6½in. diam × 1in. thick. In sparkling, unused condition.

SEMI-CONDUCTOR MODULES
Ice cube size encapsulated circuits

Solid state semi-conductor modules—fully transistorized and completely wired and tested circuits that only require a 6-volt battery and connection to input and output to provide a compact ready-made unit. Encapsulated types are shockproof and almost indestructible. Supplied with instructions.

PUBLIC ADDRESS AMPLIFIER needs only carbon microphone and any speaker. Frequency response designed to provide maximum intelligibility. With 15in. speaker sound covers hundreds of yards. Fully encapsulated. Size only 1½in. × 1½in. × ⅞in. **22/6. P. & P. 1/-.**

METRONOME—requires only 2 megohm potentiometer and any P.M. speaker to produce accurate repetitive beats at adjustable rates from 40 to more than 208 beats per minute. Low battery drain: simple connections. **22/6. P. & P. 1/-.**

2-WATT GRAM. AMPLIFIER—just connect to any crystal pick-up and an 8 ohm speaker for above average output with excellent tonal quality. 1-megohm potentiometer recommended for volume control. Extremely compact, high quality unit. **30/-. P. & P. 1/-**

CODE PRACTICE OSCILLATOR—Simply connect with morse key, any P.M. speaker and any 1½-6 v. battery. Fully transistorized and assembled on rigid board, size 2 × 1⅞in. **12/6 P. & P. 1/-.**

FIRE ALARM—Module contains temperature sensor and operates in conjunction with 8 ohm. loudspeaker and 2 megohm potentiometer. Increase of room temperature above preset level immediate triggers screaming syren alarm. **50/-. P. & P. 1/-.**

BURGLAR ALARM Needs only 8 ohm. loudspeaker, switch and microswitch (or reed switch and magnet) to complete. Operation of sensing switch trigger upward screaming siren to give instant alarm. For home or motor car protection. **30/-. P. & P. 1/-.**

MINIATURE MERCURY SWITCH
ALMOST INDESTRUCTIBLE FEATHERLIGHT OPERATION

Encapsulated in copper-plated steel tube only 3/16in. dia. × ⅞in. long (inc flange). Tube provides one contact and other contact is ⅛in. long wire fused into glass centre of tube base. 20 deg. movement makes or breaks contact; vacuum sealing ensures unchanged contract resistance throughout life. Construction permits switch to be simply clipped into position. Rating 240v. A.C. mains operation at 1 amp., may also be used with D.C. current from small torch battery. Can be installed almost anywhere to operate lights automatically or to provide simple warning or safety devices.

2 for 7/6 post free.

GUARANTEED TRANSISTORS

O.C.44 and O.C.45 2/6. O.C.71 3/6. O.C.26 6/6. Matched pairs of G.E.T. 8 (max. volts 32, output 50 w. in push-pull) **14/6** per pair. Add packing and postage.

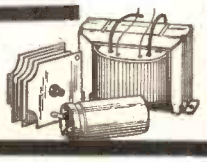
SILICON RECTIFIERS

XU612 50 p.i.v. 500 mA. 2/6. R.T.C.D. 1,000 p.i.v. 500 mA. 7/6. Silicon bridge 24v. D.C. 6 A. full wave **£2**.

ADJUSTABLE POT CORE

Mullard Vinkor Type LA 18 mm. adjustable core, suitable for frequency range 120 Kc/s. to 1.2 mc/s. Effective permeability 25. Turns for 1 mH. 133. Complete and brand new **4/6**. P. & P. 1/-.

I.A. MODEL CONTROL POWER PACK

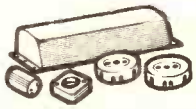


A complete kit—mains transformer, rectifier, and smoothing condensers—all the components to make a splendid 12 volts, 1 amp. power pack for model control, charging, etc. Supplied with full wiring instructions. **18/6** *P. & P. 2/6.*

SIGNAL GENERATOR

Covering 100 Kc/s.–100 Mc/s. on fundamental and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. x 6¾in. x 5¼in., grey hammer finish. Incorporating three miniature valves and metal rectifier. A.C. mains 200–250 v. Internal modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F. output continuously variable, 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.

£7/5/0 Post and packing 6/6 extra.



40W FLOURESCENT LIGHT KIT

Incorporating **GEC** Choke size 8¼ x 1¾ x 1¼, 2 bi-pin holders, starter and starter holder. **11/6** p. & p. 3/6.

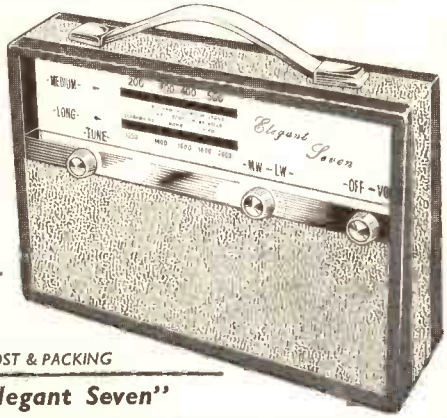
Similar to above: 80 W Fluorescent Light Kit incorporating **GEC** choke size 11¾ x 1¾ x 1¾, 2-bi-pin holders, starter and starter holder. **17/6** p. & p. 4/6.

POCKET MULTI-METER. Sizes 3⅞ x 2⅛ x 1⅜in. Meter size 2¼ x 1⅜in. Sensitivity 1,000 OPV on both A.C. and D.C. A.C. and D.C. volts 0–15, 0–150, 0–1,000. D.C. current 0–150 mA. Resistance 0–100KΩ. Complete with test prods, battery and full instructions. **39/6**, plus 1/6 P. & P.

50 MICRO-AMP. METER Movement by world-famous manufacturer. Size 3in. x 2¾in. **25/-**, plus 1/6 P. & P.

SPECIAL OFFER—Power Supply Kit

To purchasers of "Elegant Seven" parts, incorporating mains transformer etc. AC mains 200/250v output 9v 100mA 7/6.



ONLY **£4.4.0**

PLUS 5/6 POST & PACKING

The "Elegant Seven"

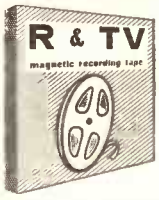
Combined Portable and Car Radio

- ★ **7-transistor superhet. Output 350 mW.**
- ★ **Two-tone grey wooden cabinet, fitted handle with silver-coloured fittings, size 12¼in. × 8¼in. × 3¼in.**
- ★ **Horizontal tuning scale, size 11¼in. × 2¾in. in silver with black lettering.**
- ★ **All stations clearly marked.**
- ★ **Ferrite-rod internal aerial.**
- ★ **IF 460 kc/s.**

The Radio with the "Star" Features

- ★ **Operated from PP9 battery.**
- ★ **Fully comprehensive instructions and point-to-point wiring diagram.**
- ★ **Printed circuit board, back-printed with all component values.**
- ★ **Fully tunable over medium and long waveband.**
- ★ **Car aerial socket.**
- ★ **Full after-sales service.**

4in. SPEAKER. Parts list and circuit diagram **2/6.** FREE with parts.



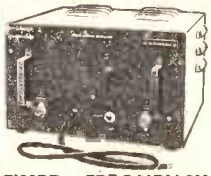
FIRST QUALITY PVC TAPE

5¾ in. Std. 850 ft. ...	9/-
7 in. Std. 1200 ft....	11/6
3 in. L.P. 240 ft. ...	4/-
5¾ in. L.P. 1200 ft....	11/6
7 in. L.P. 1800 ft. ...	18/6
5 in. D.P. 850 ft. ...	10/6
3 in. T.P. 600 ft. ...	8/-
5 in. T.P. 1800 ft. ...	20/6
7 in. T.P. 3600 ft. ...	37/6

P. & P. on each 1/6, 4 or more, post free.

TRANSISTOR INVERTOR. 50 v. D.C. input. Output 240 v. A.C. 40 watts incorporating transformers, choke, condensers and 2 Get 573. In solid 16 gauge aluminium case size 15in. x 6in. x 2½in. by famous manufacturer.

19/6 Plus 6/- P. & P.

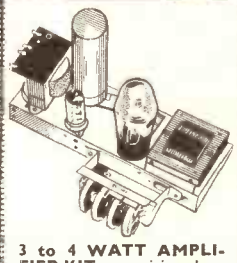


FIXED FREQUENCY SIGNAL GENERATOR Crystal control in metal case, size 10in. x 6in. x 6in, incorporating 2 FC13 valves, mains transformer, metal rectifier, choke, indicator lamp, crystal and numerous components. Modulated and unmodulated output sockets. Originally used for I.T.V. frequencies. Brand new. **39/6** plus 6/- P. & P. A.C. mains 200–250 volts.

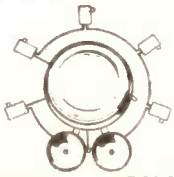
B.S.R. MONARCH UA14 WITH FUL-FI HEAD. 4-speed, plays ten records, 12in., 10in. or 7in., at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position: colour, brown. Dimensions: 12½ x 10¾in. Space required above baseboard 4¾in., below baseboard 2¾in. Fitted with Ful-Fi turnover crystal head, **£5/19/6.** P. & P. 6/6.

B.S.R. UA16, similar to the above, **£6/12/6.** P. & P. 6/6.

B.S.R. GU7, 4-speed, single player, complete with pick-up on uniplate with automatic switch. **£3/19/6.** P. & P. 5/6.

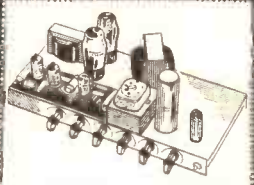


3 to 4 WATT AMPLIFIER KIT comprising chassis 8¾in. x 2½in. x 1in. Double wound mains transformer, output transformer, volume and tone controls, resistors, condensers, etc. 6V6, ECC81 and metal rectifier. Circuit 1/6 free with kit. **29/6** plus 4/- P. & P.



RINGO BURGLAR ALARM. A.C. mains 200–240 volt. Fire salvage slightly tarnished. List price 7 gns. Our price complete with double gong bell, five micro. switches and full instructions. **49/6** P. & P. 4/-.

SILICON RECTIFIERS. 250 v. P.I.V. 750 milliamps. Six for **7/6**, post paid.



6-VALVE 15 WATT PUSH-PULL AMPLIFIER. 15 x 7 x 1½in. A.C. mains 200-250 volts. 4 inputs with controls for same and bass and treble lift controls. Tapped for 3 and 15 ohm speakers. Extra H.T. and L.T. for F.M. Tuner supplies, etc., built and tested. **7 gns.** plus **12/6** P. & P.

RADIO AND T.V. COMPONENTS (ACTON) LTD.

21A, HIGH ST., ACTON, LONDON, W.3.

Goods not despatched outside U.K. All enquiries S.A.E. Terms C.W.O. SHOP HOURS 9a.m.—6p.m. EARLY CLOSING WEDNESDAY.

VALVES

Brand new, individually packed and guaranteed

AC/HL 4/6
ACP4 6/-
AC6PEN 5/-
AL60 .. 5/-
AR8 .. 5/-
ARP3 3/-
ARP12 2/6
ARP21 7/-
ARP24 3/6
ARP34 4/-
ARTP1 6/-
ATP4 2/3
ATP7 5/6
AU7 55/-
BL63 10/-
B84 .. 8/-
B85 ..20/-
B884 47/6
B2134 16/-
BT11 25/-
BT35 25/-
BT45 150/-
BT83 35/-
CC3L .. 2/-
CL33 .. 9/-
CV71 .. 3/-
CV77 .. 6/-
CV102 1/-
CV103 4/-
CV4014 7/-
CV4015 5/-
CV4025 10/-
CV4046 40/-
CY31 .. 5/6
D1 .. 1/6
D41 .. 3/3
D61 .. 6/-
D77 .. 3/3
DA30 12/6
DA60 75/-
DAF96 6/-
DD41 4/-
DET5 8/-
DET20 2/-
DET25 15/-
DF73 .. 5/-
DF91 .. 3/-
DF92 .. 3/-
DF96 .. 6/-
DK92 6/6
DK96 5/6
DL92 5/-
DL93 6/-
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E80F 23/-
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E1148 2/6
E1266 50/-
E1415 30/-
E1524 12/6
EA50 1/-
EA73 7/-
EABC80 5/-
EAC91 3/6
EAF42 8/-
EB34 1/6
EB91 3/-
EBC33 6/-
EBC41 7/-
EBC81 5/-
EBF80 5/-
EBF83 7/6
EBF89 6/9
EC52 4/-
EC53 12/6
EC70 4/-
EC90 2/-
EC91 3/-
ECC81 4/-
ECC82 5/-
ECC83 6/-
ECC84 5/6
ECC85 6/6
ECC91 4/-
ECF82 7/-
ECH42 8/-
ECH81 5/-
ECH83 7/6
ECL80 6/-
ECL82 7/6
ECL83 10/-
ECL86 10/-
EF36 .. 3/6
EF37 .. 7/-
EF39 .. 5/-
EF40 .. 8/-
EF41 .. 6/-
EF50 .. 2/6
EF52 .. 6/-
EF55 .. 8/-
EF71 .. 7/6
EF72 .. 5/-
EF53 .. 4/6
EF74 .. 4/-
EF80 .. 5/-
EF85 .. 4/6
EF86 .. 6/6
EF89 .. 3/9
EF91 .. 2/9
EF92 .. 2/-
EF95 .. 5/-
EF183 8/-
EF184 8/-
EHT1 300/-
EL32 .. 3/9
EL34 ..10/-
EL35 .. 5/-
EL38 ..17/6
EL41 .. 7/-
EL42 .. 8/-
EL50 .. 8/-
EL81 .. 8/-
EL83 .. 6/3
EL84 .. 5/-
EL85 .. 8/-
EL91 .. 4/6
EL95 .. 5/-
EL360 20/-
EM80 6/-
EM81 7/6
EM84 6/3
EM85 9/-
EN31 10/-
ESU208 6/-
EY51 5/6
EY86 6/6
EY91 3/-
EZ40 5/-
EZ41 6/6
EZ80 .. 5/6
EZ81 .. 3/6
F/6057 5/-
F/6061 5/-
F/6063 4/-
FW4/5006/8
FW4/8008/6
G1/236G 9/-
G1/371K
19/-
G50/2G 5/-
GZ32 10/-
GZ34 10/-
H63 .. 7/-
HK54 22/6
HL2K 2/6
HL23 6/-
HL23DD
5/-
HL41 4/-
HVR2 9/-
K3A ..30/-
KT8C 22/-
KT32 8/-
KT33C 6/-
KT44 5/9
KT63 4/-
KT66 12/9
KT67 15/-
KT76 8/6
KT88 20/-
KTW61 4/6
KTW63 2/-
KTZ41 6/-
KTZ63 5/-
LP2 ..10/-
M8100 9/-
M8142 12/-
M8190 5/-
MH4 .. 5/-
MHLD6 10/-
ML6 .. 6/-
N108 .. 8/-
NE17 7/-
NGT2 10/-
OB3 .. 7/-
OC3 .. 5/-
OD3 .. 5/-
OZ4A 5/-
PCC84 5/-
PCC85 7/-
PCC89 10/-
PCF80 6/6
PCF82 6/6
PCF84 6/-
PCL81 9/-
PCL82 6/-
PCL83 8/3
PCL84 7/-
PCL85 8/6
PCL86 9/-
PEN25 4/6
PEN46 3/-
PEN220A
3/-
PL36 .. 7/6
PL38 ..16/-
PL81 .. 7/-
PL82 .. 5/-
PL83 .. 5/-
PL84 .. 6/6
PM24A 5/-
PT15 ..10/-
PT25H 7/6
PT25M 7/6
PX4 14/-
PX25 9/-
PY32 9/6
PY33 8/6
PY80 5/6
PY81 5/6
PY82 5/-
PY83 6/-
PY800 6/6
PZ1-35 9/-
PZ1-75 12/-
QP21 .. 6/-
QP25 .. 5/-
QP230 5/-
QS150-15
10/-
QS95/10 5/6
QS1202 8/-
QV04/7 8/-
R3 .. 8/-
RG4/1250
60/-
RK72 6/-
S130P 15/-
S130 ..12/6
SP2 .. 8/6
SP41 .. 1/6
SP61 .. 1/6
SP210 3/6
STV280/40
12/6
STV70/80
8/-
SU2150A
10/-
T41 .. 6/6
TP22 .. 5/-
TP25 ..15/-
TT11 .. 5/-
TT15 ..35/-
TTR31 45/-
TZ0520 4/-
TZ20 ..16/-
TZ40 ..30/-
U81 .. 8/-
U12/14 8/-
U17 .. 5/-
U18 .. 6/-
U25 ..11/-
U27 .. 8/-
U52 .. 5/-
UABC80 4/6
UBC41 6/-
UBF80 5/6
UBF89 6/6
UBL21 11/-
UCC85 6/6
UCH42 6/6
UCH81 6/-
UCL82 8/-
UCL83 10/-
UF41 7/-
UF89 6/-
UL41 6/-
UL84 5/6
UU5 7/-
UU9 .. 8/6
UY21 7/6
UY41 4/-
UY85 5/-
V1120 4/-
V1507 5/-
V1924 20/-
VMP4G 12/-
VP23 .. 3/-
VP41 5/-
VP133 9/-
VR99 8/-
VR105/30
5/-
VR150/30
5/-
VT4C 20/-
VU33A 4/-
VU39 6/-
VX3256 4/-
W21 .. 5/-
W118 8/-
W119 .. 8/-
X66 .. 7/6
X118 .. 8/-
X145 .. 8/-
YF .. 1/-
Y63 .. 5/-
Y65 .. 4/-
Y66 .. 8/-
Z21 .. 6/-
Z800U 20/-
Z801U 10/-
1A3 .. 3/-
1A5GT 5/-
1B22 ..30/-
1C5GT 6/-
1D8GT 6/-
1E7G 7/6
1F2 .. 3/-
1G6GT 6/-
1L4 .. 2/6
1LA6 .. 6/-
1LC6 .. 7/-
1LH4 4/-
1N21B 5/-
1N43 .. 4/-
1N70 .. 4/-
1R4 .. 5/-
1R5 .. 3/6
1S4 .. 5/-
1S5 .. 4/6
1T4 .. 2/-
2A3 .. 5/-
2A5 .. 6/-
2B26 .. 8/-
2C26 .. 7/-
2C26A 3/-
2C34 .. 2/6
2C43 42/6
2C45 22/6
2C46 ..30/-
2C51 ..12/-
2D21 .. 5/-
2X2 .. 3/-
3A4 .. 4/-
3A/108A
20/-
3A146J 35/-
3A167/M
25/-
3B7 .. 5/-
3B24 .. 5/-
3B28 ..15/-
3D6 .. 4/-
3E29 ..50/-
3Q4 .. 6/-
3Q5GT 7/6
3S4 .. 4/-
3V4 .. 5/9
4C27 ..35/-
4D1 .. 4/-
5A173G 5/-
5A174G 5/-
5R4GY 9/-
5T4 .. 7/-
5U4G 4/6
5V4G 8/-
5X4G 8/6
5Y3G 4/-
5Y3GT 5/-
5Y3WGTB
9/-
5Z4G 6/6
6AB7 4/-
6AC7 2/-
6AG5 2/6
6AG7 6/-
6AH6 10/-
6AJ7 3/-
6AK5 5/-
6AK6 6/-
6AK7 6/-
6AL5 .. 3/-
6AL5W 7/-
6AM5 2/6
6AM6 4/-
6AQ5 7/-
6AQ5W 9/-
6AS6 4/-
6AS6W 9/-
6AS7G 20/-
6AT6 .. 3/6
6AU6 7/-
6AX4 8/-
6B4G 8/-
6B7 .. 6/-
6B8G .. 2/6
6BA6 .. 4/-
6BA7 .. 5/-
6BE6 .. 4/3
6BJ7 7/-
6BR7 9/-
6BW6 9/-
6C4 .. 2/-
6C5G 2/6
6C5GT 6/-
6C6 .. 4/-
6C6G .. 3/-
6C8G .. 3/-
6C21 80/-
6CH6 .. 4/6
6CL6 .. 9/-
6D6 .. 3/-
6E5 .. 6/-
6F5G 5/3
6F5GT 5/9
6F6G .. 4/-
6F7 .. 6/-
6F8G .. 6/6
6F12 .. 4/6
6F13 .. 5/-
6F17 .. 5/-
6F32 .. 4/-
6F33 .. 3/-
2G6G 2/6
6H1 .. 6/-
6H6M 1/6
6J4WA 10/-
6J5G .. 2/-
6J6 .. 3/6
6J6W .. 6/-
6J7G .. 5/-
6J7M 8/-
6K6GT 5/6
6K7G 2/-
6K7GT 4/9
6K8G 3/-
6K8GT 8/3
6K8M 8/6
6K25 12/-
6L5G 6/-
6L6G .. 6/-
6L6GA 7/6
6L7G 4/-
6L34 .. 4/6
6LD20 5/9
6N7 .. 6/-
6N7G.. 5/9
6Q7G .. 6/-
6R7 .. 5/6
6SA7 .. 7/-
6SA7GT 6/6
6SC7 .. 7/-
6SC7GT 5/-
6SG7 .. 5/-
6SF5GT 5/6
6SH7 .. 3/-
6SJ7 .. 5/-
6SJ7GT 5/6
6SJ7Y 6/6
6SK7 .. 4/6
6SL7GT 5/6
6SN7 .. 3/6
6SQ7 .. 6/-
6SS7 .. 2/-
6U4GT 9/6
6V6G .. 5/-
6V6GT 5/6
6V6M 8/-
6X4 .. 3/6
6X5G 5/-
6X5GT 5/3
6Y6G 6/-
6-30L2 10/-
6Z4 .. 5/-
7B7 .. 7/6
7C5 .. 10/-
7C6 .. 7/-
7C7 .. 6/-
7H7 .. 7/3
7Q7 .. 7/-
7V7 .. 5/-
7Z4 .. 4/6
8D2 .. 2/6
9D2 .. 8/-
9D6 .. 3/6
11E3 37/6
12A6 .. 2/6
12AH7 5/-
12AH8 11/-
12AT7 4/-
12AU7 5/-
12AX7 6/-
12AY7 10/-
12BA6 5/6
12BE6 7/-
12BH7 7/-
12C8 3/-
12H6 .. 2/-
12J5GT 2/6
12J7GT 6/6
12K7GT 2/-
12K8M 10/-
12Q7GT 8/3
12SA7 7/-
12SC7 4/-
12SG7 3/-
12SH7 3/-
12SJ7 5/9
12SK7GT
3/-
12SN7GT
5/9
12SR7 5/-
12Y4 .. 2/-
14L7 .. 7/-
15D2 .. 6/-
19E2 15/-
19G3 ..10/-
19G6 .. 9/-
19G7 .. 5/-
19H1 .. 6/-
19M1 .. 5/-
20P4 ..13/-
21B6 .. 9/-
25L6GT 5/6
25Y5 .. 6/-
25Z4G 6/6
25Z5 .. 7/6
25Z6GT 8/6
28D7 .. 6/-
30 .... 5/-
30C15 9/6
30F5 8/6
30FL1 10/6
30P19 12/-
30PL1 8/-
35L6GT 7/-
35T 17/6
35W4 5/-
35Z3 .. 8/-
35Z4GT 6/-
35Z5GT 6/-
37 .... 4/-
38 .... 4/-
41MP 4/-
44A/160N
30/-
50L6GT 8/-
53A .. 7/6
57 .... 6/-
58 .... 6/-
59 .... 6/-
75 .... 5/6
76 .... 5/-
77 .... 6/6
78 .... 5/-
80 .... 5/6
81 .... 9/-
82 .... 8/-
84 .... 8/-
85A2 .. 8/-
210VPT
7-pin 2/6
2158G 6/-
220PA 7/-
220TH 4/-
225DD 9/-
307A .. 5/6
313C ..25/-
357A ..70/-
368A .. 5/-
393A ..15/-
446A .. 8/-
703A ..30/-
705A ..10/-
715B ..60/-
717A .. 3/-
724A ..15/-
801 .. 6/-
803 ..22/6
807 .. 8/-
808 .. 8/-
813 ..63/-
815 ..35/-
829A ..30/-
829B ..50/-
830B .. 4/-
832A ..45/-
832 ..15/-
837 .. 9/-
843 .. 5/-
860 ..10/-
866A ..14/-
884 ..10/-
954 .. 4/6
955 .. 2/6
956 .. 2/-
957 .. 5/-
958A .. 4/-
1612 .. 5/-
1616 .. 3/-
1619 .. 5/-
1625 .. 6/-
1626 .. 3/-
1629 .. 4/6
2051 .. 5/-
4043C 13/6
4063 .. 8/-
4313C 30/-
5704 .. 9/-
5726 .. 6/-
6064 .. 7/-
6065 .. 6/-
6080 ..22/-
7193 .. 1/9
7475 .. 2/-
8013A 25/-
8020 .. 8/-
9001 .. 3/-
9002 .. 4/6
9003 .. 6/-
9004 .. 2/6
9006 .. 2/6

C.R. Tubes

CV1596 (09J) 55/-
E4504/B/16 28/-
VCR97 28/-
VCR138 30/-
VCR138A 40/-
VCR139A 35/-
VCR517B 40/-
VCR517C 40/-
3FP7 45/-
5CP1 30/-
5FP7A 12/-

Photo Tubes

CMG8 5/-
GS16 12/6
931A 55/-
6097C 350/-

Special Valves

ACT6 £8
K301 £4
KRN2A £3/10/-
1B24 25/-
2J22 £2/10/-
2J54 £3
417A 30/-
3J/92/E £37/10/-
714AY £4
723A/B 50/-
725A 30/-
726A 19/-

Transistors

OC44 6/-
OC45 6/-
OC71 5/-
OC72 7/-
OC81 7/-
OC82 10/-

MANY OTHERS IN STOCK including Cathode Ray Tube and Special Valves.

All U.K. orders below £1 P. & P. 1/-: over £1 2/-: orders over £3 P. & P. free: C.O.D. 3/6 extra. Overseas Postage Extra at Cost.

MARCONI COMMUNICATION RECEIVERS

C.R.150. Frequency coverage 2-60 Mc/s. in 5 bands. Two I.F.s 1st 1,600 kc/s. 2nd 465 kc/s. Image signal protecting over 40 dB up to 30 Mc/s. and 20-40 dB from 30-60 Mc/s. Self-checking calibration (built-in calibrator). Stabilisation of supply and temperature compensation. Electrical and mechanical band-spread. Metering and visual tuning indicator. Band pass from 100 c/s. to 10 kc/s. in 5 stages. Acoustic filter associated with 100 c/s. Bandpass position for CW reception. Facilities for diversity reception. Excellent checked condition, **£49.** Mains P.S.U. by P.C.A. Radio, **£4/10/-,** carriage 30/-.

C.R.150/2. Frequency coverage 1.5-22 Mc/s. in 4 bands, all other features as in C.R. 150. Price **£35.** Carriage 30/-.

SEALED HIGH SPEED SIEMENS RELAYS. 1700+1700 ohm, **15/-.** P. & P. 1/6.

DUMONT MODEL 241 OSCILLOSCOPE in fully working condition **£22/10/-.** P. & P. 30/-.

"CONNECT AND FORGET, CANNOT OVERCHARGE" "ESSTRON" MARK I AUTOMATIC BATTERY CHARGER. Initial charging rate 6-7 amps. The charging rate automatically adjusts itself to the charge in the battery. Automatic current and voltage control. Patented application of magnetic amplification to battery charging. Indicator lights show battery fully charged, receiving charge incorrectly connected or faulty cells. Mains voltage 200/250 v. Built for 6 or 12 v. batteries. Measurements 7 x 5 x 5½in. Weight 8½lb. Price **£7/19/6.** P.P. 3/6.

POWER SUPPLY & L.F. AMPLIFIER UNIT NO. 3. Input 12 v. 3 amp. Output 145 v. 50 mA. Synchronised vibrator and extremely efficient smoothing. Stabilized heaters supply. Valves, IL4 and 3A4. Many practical possibilities, i.e., car radio, etc. Diagram supplied. Brand new, **37/6.** P. & P. 8/-.

H.R.O. SENIOR TABLE MODEL in excellent, fully checked and tested condition together with set of 9 general coverage coils and mains P.S.U. **£28.** Carriage & Packing 30/-.

NEW DHR. HIGH-RESISTANCE HEADPHONES. 14/-. P. & P. 1/6.

WELL PROVEN RELIABLE COMMUNICATION RECEIVER P.C.R.2.

(Made by Pye). 120 kc.—350 kc. 525 kc.—1,600 kc. 6 Mc.—22 Mc. Overall sensitivity 1-2μV. S/noise ratio 10 dB at 6 μV. Circuit incorporates an R.F. stage, two I.F. stages, tone control, A.V.C. antenna trimmer, 6V6 output. Set in fully working condition together with headphones and speaker plug. **£7/12/6,** carriage 15/-. Ditto but with built-in power supply for 210/250 v. A.C. **£9/19/6.** Carriage 15/-.

CARBON INSET MICROPHONE. G.P.O. types **2/6.** P. & P. 1/6.

TELEPHONE HANDSET. Standard G.P.O. type, new **12/-.** P. & P. 2/-.
Large selection of mains and Heavy Duty L.F. TRANSFORMERS.

EVERSHED MEGGER CIRCUIT TESTER 2 ranges. 0-1,000 ohms. 100-200,000 ohms. with test leads, leather carrying case. Tested **£4/19/6.** P. & P. 3/6.

AR88D RECEIVERS. Fully reconditioned, **£55,** rebuilt models **£85.** Brand new **£95.** Carriage paid U.K.

P. C. RADIO LTD.
170, GOLDHAWK RD., W.12
SHEpherd's Bush 4946

ULTRA MODERN POWER SUPPLY UNIT. Supply voltage A.C.: 105, 110, 115, 200, 205, 210, 220, 225, 230, 240, 245, 250v. Available voltages D.C.:

(a) 1700-2050 v. (adjustable) approximately 80.5mA.
(b) 600 v. approximately 60mA.
(c) 260-350 v. (adjustable) approximately 25mA.
(d) 450 v. approximately 30mA.
(e) 100 v. approximately 150mA.

All voltages are stabilised, 5 valves, 7 silicon rectifiers, 4 Solenium HV rectifiers. Brand new **£9/10/-.** Carriage 12/-.

VERY HIGH CLASS COMMUNICATION RECEIVER TYPE BRT 402E. 150 kcs-385 kcs., 510 kcs.-30 mcs. Fully tested **£60.** Carriage 30/-.

STABILISED POWER SUPPLY UNIT TYPE 1280. (EDISWAN) with 5 independent outputs. 1. 0-300 v. 150 mA. metered and regulated. 2. 0-300 v. 75 mA. metered and regulated. 3. 200 v. 25 mA. bias voltage. 4. 6.3 v. A.C. CT 4 amps. 5. 6.3 v. A.C. CT 4 amps. Stability 0.02% **Price £48.**

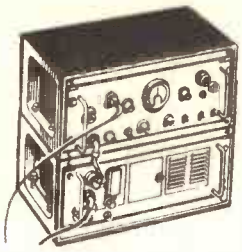
STABILISED POWER SUPPLY UNIT TYPE R 1095 (EDISWAN) with 2 independent outputs. 1. D.C. 120-250 v. 50 mA. metered and regulated. 2. A.C. 6.3 v. C.T. 3 amps. Stability 0.02%. **Price £18.**

STABILISED POWER SUPPLY UNIT TYPE R 2001. (EDISWAN) with 2 independent outputs. 1. 0-100 v. 50 mA metered and regulated by coarse and fine adjustments. 2. 250 v. Bias at 5 mA. Stability 0.02%. **Price £18.**

VARIOMETER for No. 19 set, **17/6.** P. & P. 3/-.

WIDE RANGE MULLARD VALVE VOLT METER TYPE E 7555/2. 100 mV-500 v. D.C. or A.C. peak from 35 c. to 5 mc. additional range 500 v. to 15 kc. D.C. or peak A.C. Frequency response with probe is lever from 35 c. to 100 mc. Power supply 110/245 v. A.C. Price **£25.** Carriage £1.

Open 9-5.30 p.m. except Thursday 9-1 p.m. **PERSONAL CALLERS WELCOME**



CARRIER FREQUENCY SHIFT ADAPTOR. This modern equipment of recent manufacture is in excellent condition and suitable for operation with most Service Receivers. IF frequency adjustable internally 445–475 kc/s. The adaptor will operate two independent Teleprinters. Power supplies A.C. mains 230 v. or 24 v. D.C. Price £12/10/-, Carr. 25/-.

RELAY UNIT. G.P.O. 600 types 5 relays 150 ohm 1 set C/O., and 5 relays 400 ohm 2 M., 1 set C/O., in metal box 8 × 6 × 5in., £2, post 5/-.
FACSIMILE KEYER UNIT KY 75 SRT, 115/230 volts, £25 each.
MODULATOR MD 168/UX (for the above keyer), £12/10/-.
SIGNAL GENERATOR 1-196A. Freq. range 100-156 mc/s. Power requirements 115 v. A.C. or batteries. £3 each. Carr. 15/-.
METERS. 0–60 amps., centre zero 6in. scale, proj. m/c., 17/6 each, 5/- post. 0–150 amps., centre zero 6in. scale, proj. m/c. (requires external shunt), 17/6 each, 5/- post. 0–100 amps., 6in. scale, A.C./D.C., 30/- each, 6/6 post. 90–180 v., A.C./D.C., 4in. scale, £1 each, 5/- post.
BC-221 or LM 13. Freq. meter complete with original charts in good working order. Range 125 kc/s.–20 Mc/s., £16/10/-, carr. 15/-.
SIGNAL GENERATORS
TF.144G. 230 v. A.C. 85 kc/s.–25 mc/s. In excellent condition, £16/10/- each, 25/- carr.
TS.12AP. Standing Wave Indicator Equipment. Complete with Amplifier and waveguide plumbing equipment, £12/10/- each, 15/- carr.
TS.36AP Power Meter, with accessories, used for checking radar outputs, £5 each, 10/- carr.
DE-ICER, Controller Mk. 3. Contains 10 relays D.P. changeover heavy duty contacts, 1 relay 4P, C/O. (235 ohms coil). Stud switch 30-way relay operated, one five-way ditto, D.C. timing motor with Chronometric governor 20–30 volts 12 R.P.M., geared to two 30-way stud switches and two Ledex solenoids, 1 delay relay, etc., sealed in steel case, size 4 × 5 × 7in., £3 each, post 5/-.
BC640 MODULATOR UNIT. 2 × 811's, mod. transformer and fil., trans. complete mod. unit fits 19in. rack 50 watts, £5/10/-, carr. £1.
GEARED MOTORS (Reversible).
20-30 v. D.C. 72 r.p.m., 17/6, post 2/6.
28 v. 150 r.p.m., 25/-, post 2/6.
24 v. Open gears with governor, approx. 10 r.p.m., 25/-, post 2/6.
24 v. D.C., 1.4 r.p.m., reversible with two micro switches inside gear box, silent operation, £2 each, post 5/-.

MARCONI V. LVE VOLTMETERS TF428-B/1. Ranges: 0 to 1.5, 5, 15, 50 and 150 volts. Fitted with probe unit for RF measurements. 230 v. mains input. Brand new, £12/10/- each, carr. 10/-.

TCS MODULATION TRANSFORMER 20 w. Pri., 6,000 ohm C.T. Sec., 6,000 ohm. 25/- each, post 3/6. **MICROPHONE TRANSFORMER.** Pri., 75 ohm. Sec., 125,000 ohm. 10/- each, post 2/6.
OUTPUT TRANSFORMER. Pri., 7,500 ohm. Sec., 500 ohm. C.T., 2.5 w. 12/6 each, post 3/-.
POWER SUPPLY unit for SENDER No. 36, 110-240 v. A.C. input, contains Speech amplifier. Modulator and External power supplies, 3 × FW4/500 rectifiers provide H.T. for F.R. unit Speech amplifier 6C5G, Modulator 2 × 6C5G and 2 × 807 output. Size 24 × 16 × 14 inches. Housed in a fine oak case with circuit. Weight 110 lbs. As new, £6/12/6, carr. 30/-.
CONVERTERS. Type 8 a., 24 v. D.C., 115 v. A.C. at 1.8 amps. 400 cycles, 3-phase. £5 each, carr. 7/6.
CONDENSERS. 1 mfd., 20 kv., £6/12/6 each, post 12/6 each. 0.25 mfd., 32,500 volts Wkg. £5 each, post 12/6 each. 150 mfd., 290 volts A.C. £5 each, post 12/6. 50 mfd., 330 volts A.C. 40/-, post 4/-. 10 mfd., 1,000 v. 12/6, post 2/6. 8 mfd., 1,500 volts, 17/6, post 2/-. 8 mfd., 1,200 volts, 12/6, post 3/-. 8 mfd., 600 volts, 8/6, post 2/6. 0.25 mfd., 2 kv. 4/-, post 1/6. Vacuum condenser 50 pf. 32 kv. 30/-, post 1/6. 6 pf. 20 kv. 22/6, post 1/6. All the above are new in cartons.
POWER FACTOR CONDENSERS. 160 mfd., 290 v. A.C. working. £5/10/- each, carr. 10/-.
4 mfd., 12,500 v. D.C. working, £7/10/- each, carr. 15/-.
BLOWER MOTORS. 24 v. D.C. (small U.S.A.), 12/6, post 2/-.
TELEPRINTERS. Type 7B, used, good condition. 24 v. D.C. £12/10/- each, carr. £1.
OSCILLOSCOPES, Cossor 1035 and 1049, used condition, £30 each. Hartley type 13A, £25 each. Solartron Type CT316, £20 each.
INVERTERS. Type AN3499, 28 v. D.C., 9.2 amps. input, 115 v. 400 c/s 3 phase, £5 each, post 5/-.
TX DRIVER UNIT. 100-156 Mc/s. Ideal for two meters, Valves 3C24, in excellent condition, fits 19in. rack, £5 each, carr. 20/-.

CONTROL UNIT. 230 v. A.C., output 24 v. 2 amps., 230 v. A.C. solenoid switch, 15 amps., plus relays and switches, etc., £2/10/-, carr. 12/6.
RECEIVERS. HRO. Used condition, less coils, £10 each, carr. £1. S.36, used condition, freq. 30-143 Mc/s. £25, carr. £2. S.27/U, used, freq. 143-210 Mc/s., £25, £2 carr. C.52, used, freq. 1.75-16 Mc/s., £5, carr. £1. H.63 (similar to 1392), 100-156 Mc/s., £5, carr. £1.

MARINE RADAR EQUIPMENT. Complete installation for 110/220 v., 3 cmm., made by B.T.H. Ltd. The equipment is mounted in a weatherproof steel van 6 × 6 6ft., with the scanner on top to rotate 360 deg. The units are available with service manuals and some spares. £500 each. F.O.B.

UNISELECTORS. 6 bank, 25 way, 20 ohm. coil, £2 each, post 2/6; 5 bank, 25 way, 20 ohm. coil, 35/- each, post 2/6. (Ex-new equipment.)
BOMB SELECTOR UNIT, complete with uniselector 3B., 25 watt, 22 ohms, magnetic counter 0-40, and 1 relay 500 ohm. 2 make, 50/- each, post 3/6.
HEADPHONES. DLR5, 10/- pair, 2/6 post. No. 10 headset and microphone, 15/-, post 2/6. M/C phones with chamois ear muffs and jack plug, 17/6 pair, post 2/6.

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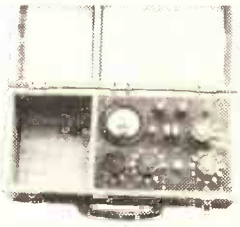

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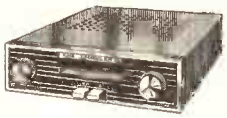

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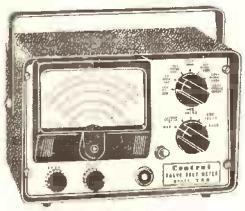

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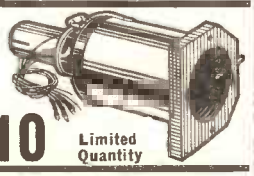

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VIKING TRANSISTOR 50-WATT AMPLIFIER

50-watt output. Superb amplifier for all music and P.A. work—ideal for guitars, groups, etc. Fully transistorised for maximum efficiency. 4 inputs with mixing facilities plus reverberation/echo chamber. Fully built and guaranteed. In strong wood cabinet covered in washable material, size approx. 22 x 10 x 6in. Output imp. 15 ohms. For operation on 200/250 v. A.C. mains.
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High quality valve model. Guitar and P.A. amplifier. A.C. mains operated—30-watt output. 8 inputs, fitted with 4 separate volume controls for mixing, also Bass and Treble controls. 15 ohms out. British made, highest quality components used throughout, fully guaranteed. In strong portable case, size approx. 20 x 9 x 6in.
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2 inputs, mixing, Bass and Treble tone controls. British made. Fully guaranteed. A.C. mains operated.
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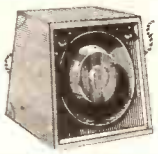

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£9.15.6 Carr. 5/6.

Three Wavebands Long, Med, Short. Five Valves: ECH81, EF89, EBC81, EL84, EZ80. 12-month guarantee. A.C. 200-250 v. Ferrite Aerial, A.V.C P.U. and Tape Sockets Negative Feedback. 5 watts 3 ohm. Chassis 13½in. × 7in. high × 5in. deep. Glass dial size 13in. × 4in. horizontal wording. Two Pilot Lamps, Four Knobs. Aligned calibrated. Chassis isolated from mains.

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Post 2/- each.

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Valves: UY85 Rectifier and UCL82 Triode/Pentode 3½ watts output. Size (inc. valves) 5 x 5½ x 2in. deep. New and Tested complete 3 ohm output tone and volume on/off controls. **ONLY 37/6** P. & P. 2/6. Ready for use 200-250 v. A.C. or can be used with 80 v. motor tap or 160 v. motor.

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Complete with ACOS LP-78 Turnover Head 20/-

Transistor Mains Eliminators 29/6
PP1-6 v., PP9-9 v. Doubles 42/6. PP1 + PPP1, PP9 + PP9, PP11 (4½ + 4½).

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RA2W 6in. Ferrite Aerial with car aerial coil,	12/6.	Spare Cores	6d.
Osc. P50/1AC	5/4.	Driver Trans. LFDT4	9/6.
1st and 2nd I.F. P50/2CC 470 kc/s.	5/7 each.	Printed Circuit, PCA1. Ready drilled and printed,	9/6.
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NEW MULLARD TRANSISTORS
OC71 6/-; OC72 7/6; OC81D 7/6; OC81 7/6; AF115 10/6; AF114 11/-; OC44 8/-; OC45 8/-; OC171 9/-; OC170 8/6; AF117 9/6. OC26 12/6; Transistor Holders 1/3. Sub Miniature Condensers. 0.1 mfd., 30 v. 1/3; 1, 2, 4, 5, 8, 16, 25, 30, 50, 100 mfd., 15 volt 2/6. Diode OA81 3/-.

Volume Controls
Long spindles. Midget size 5 K. ohms to 2 meg. LOG or LIN. L/S. 3/-. D.P. 4/6.
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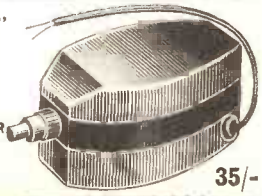
80 Ohm CABLE Coax
Semi-air spaced 6d. yd. 40 yd. 17/6. 80 yd. 25/-.
Low loss 5 dB. per 100ft. at 500 mc/s.
Ideal 625 lines 1/6 yd.

CAR AERIAL PLUGS 1/6. Sockets 1/3. COAXIAL PLUG 1/-. PANEL SOCKET 1/-. COAX. OUTLET BOXES. SURFACE OR FLUSH 4/-. BALANCED TWIN FEEDERS 6d. yd. 80 or 300 ohms. TWIN SCREENED FEEDER 1/- yd. 80 ohms. TELESCOPIC AERIALS. 12in. extends to 33in. 6/6 each.

THE "INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETIZER



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200/250 v. A.C. **35/-**

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12" GUITAR HEAVY DUTY 25w.

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5GNS.

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15 OHM VOICE COIL
20-10,000 cps
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10 WATTS AND 20 WATTS OUTPUT

● MONO FULL FUNCTION PREAMPLIFIER/ CONTROL UNIT

PRICE **£5.10.0** p.p. 2/-.

★ Dark brown and gold front panel plate 8/6.

For use with transistor power amplifiers as below or valve amplifiers—hum-free—high sensitivity—8 inputs between 1.5 mV. and 300 mV., with full equalisation. For all pickups—microphones, tuners, tape replay. Separate treble and bass with cut and boost—4 position low pass filter. Volume control, etc. Response within 3dB, 30 c/s to 20 kc/s. Output 250 mV. Overall size 9 x 2½ x 2in. Battery operated (2½ mA) or from power supply. Signal to noise ratio 70 dB at 10 watts with power amplifier. Supplied built and ready to use or as a Kit. Attractive appearance and high performance. Can be used to feed one or two Power Amplifiers.

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★ Dark brown and gold front panel plate 12/6.

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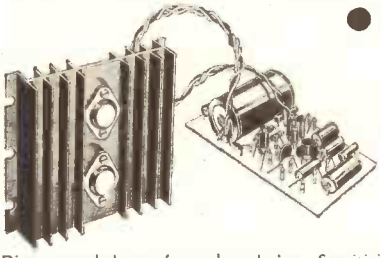
NEW! Stereo 'pick-up match' for use with above Stereo preamp, using low output pickups (2 to 10 mV at 30k to 100k ohm) and low output high impedance, as Decca Deram (25 to 75 mV 1.5 to 2 megohm).
Price built 39/6, p.p. 1/6 (Size 3 x 1½ x ½in.).



● 10 WATT POWER AMPLIFIERS

(Peak output 20 watts.)

★ 15 ohm 10 watt 40 volt supply.
£5.19.6 p.p. 2/6

★ 3 ohm 10 watt 24 volt supply.
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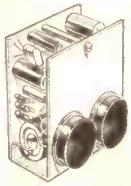
Direct coupled transformerless design. Sensitivity 100 mV. from 10 K ohm (or less) for 10 watts output. Response ± 1 dB 40 c/s. to 20 kc/s. 0.25% total distortion at 10 watts. Push-pull class B output. 60 dB feedback. Available for 3/4 ohm and 15/16 ohm output. 20 watts peak music power output per channel. Battery or mains supply operation. For use with mono or stereo preamplifiers as above. Supplied built and ready to use. 10 watts RMS music power or 20 watts peak output per amplifier.

● **MAINS UNITS.** 59/6 to power one amplifier, 69/6 to power two.

DETAILS WITH CIRCUITS ON REQUEST

TRANSISTOR PACKAGED AMPLIFIERS

● 6-Transistor printed circuit designs. Push-pull output for 3 to 5 ohm speakers. Can be battery operated. 6 mV. into 1 K ohm sensitivity. Response 40 c/s to 15 kc/s. Can be used with above preamplifiers for mono or stereo in any application requiring a low distortion low cost amplifier.



OVERALL SIZES 2½ x 2 x 1¼ inches.

● 4 watt version operates from 12 to 18 volts. **PRICE BUILT 79/6** P.P. 1/6
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★ CIRCUITS AND DETAILS ON REQUEST ★

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● 6 TRANSISTOR SUPERHET

Covers all Med./Long Waves

A new printed circuit Superhet Pocket Radio design. Features 6 matched transistors and diode with push-pull 'Cleartone' speaker output, geared tuning, Hi-flux speaker, etc. Fitted phone socket, separate wave-change switch. Easy to follow building instructions. Moulded two-tone cabinet size 5in. x 3in. x 1½in. All parts sold separately and guaranteed. After sales service.

CIRCUIT AND DETAILS ON REQUEST

● Total cost to build **85/-** P.P. 2/- (battery 2/6 extra).

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6-Transistor 3 diode med. and long wave superhet design. Features double tuned IFTS, AVC, permeability tuning with geared drive. Push-pull car filling volume. Full tuning on both wavebands. A high sensitivity printed circuit professional design to fit any type of vehicle. Case size 7 x 4 x 2in. For 12 volt positive earth or dry battery. All parts available separately. After sales service and guarantee.

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● **TOTAL COST TO BUILD**
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● 7 x 4 inch Hi-Flux speaker with baffle and car fixing kit 20/- extra.

★ CIRCUIT AND DETAILS ON REQUEST

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Features 5-Mullard transistors with 4 diodes, compact printed circuit, high gain, low distortion, superhet design. Full tuning from 87/105 Mc/s. with geared tuning. AVC and AFC. 9 volt 9 mA operation. 50 dB S/N. Output up to 1 volt audio. Easy to build and align. Overall size in cabinet 3½ x 2¼ x 4in.

All parts sold separately.

After sales service and guarantee.

★ CIRCUIT AND DETAILS ON REQUEST.

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(Cabinet Assembly 20/- extra)

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● **UNBEATABLE FOR PERFORMANCE AND DESIGN** ●

Printed circuit 6-Transistor 2-Diode superhet radio with full tuning on medium and long wave bands. Quality push-pull output up to 1 watt. Attractive portable cabinet, size 10 x 7 x 3½in. with horizontal slow motion tuning dial and push button wave change. Easy to build with superb performance. All parts sold separately. After sales service and guarantee.

★ CIRCUIT AND DETAILS ON REQUEST

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P.P. 3/6. (Batteries 6/- extra).

★ The finest portable available.

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● **PRE-ASSEMBLED PRINTED CIRCUITS**

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● For use with our Transistor 10 watt and 4 watt amplifiers.

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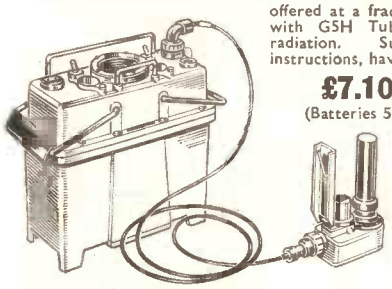

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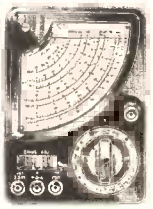

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(*Leather Cases Available)

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A SELECTION FROM OUR STOCKS

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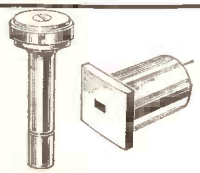

Marriot Type R/RP/3 ¼ track record-replay head and Mullard type TS erase head with mounting post. Impedance 700 ohms at 1Kc/s. Ideal for transistor circuits. Bargain Offer. **15/- Pair.**

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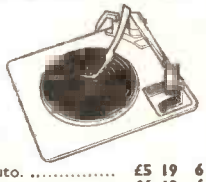

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R.M.S. 0-1.4-4-14-40-140-400-1,400-4,000 P.P.
Resistance: 2 ohm to 1,000 meg. ohm.
Decibels: —10db to +65db.
Operation: 220/240 volt A.C. Size 7 × 4¾ × 4in. Supplied brand new and guaranteed complete with probe and instructions **£12/10/-**. P.P. 3/6.

PRECISION COMBINATION VOLTMETER/AMMETER

Two separate instruments housed in polished wood case, 6in. scales with knife edge pointers. Ranges as follows: A.C. and D.C. Volts 0-100-300-600. A.C. and D.C. Current: 0-25-50-150-200 amps. Supplied complete with shunts, leads and leather carrying case. Brand new condition. **£9/19/6.** each. Carr. 7/6.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0-20 Kc/s. on 2 ranges. Output 500Ω or 5kΩ. Operation 200/250 v. A.C. Supplied in perfect order **£12/10/-**. Carr. 10/-.

MAINS ISOLATING TRANSFORMERS

230 V. to 230 V. 50 W. **16/6.** P.P. 3/-; 100 W. **29/6.** P.P. 3/6; 1,000 W. **£5.** Carr. 10/-.

CLASS D WAVEMETER NO. 1. MK. II

Crystal controlled wavemeter covering 1.9-8 Mc/s. on 2 bands. 6 v. D.C. operation. Supplied brand new with handbook, headset and case. **59/6.** Carr. 5/-.

R.107 COMMUNICATION RECEIVERS

1.2-17.5 Mc/s. Mains or 12 v. operation. Supplied in excellent condition, **£15.** Carr. 30/-.

AR88D RECEIVERS

550 kc/s.-32 Mc/s. Available in excellent "as new" condition. **£65.** Carr. 30/-.

NATIONAL H.R.O. RECEIVERS

A good selection available. S.A.E. for details.

9-TRANSISTOR 2 WAY RADIOS

Super quality. Range up to 5 miles. Complete with all accessories. **£25** per pair. Post extra. Also available, **3-TRANSISTOR MODEL.** Range up to 1 mile. Complete with all accessories. **£9/19/6** per pair. Post extra. (S.A.E. for full details.)

RECORDING HEADS

Reuter: ¼ track. Set of 2 ..... **19/6**
Miniflux: ¼ track. Set of 3 ..... **29/6**
Bradmatic: ¼ track. Set of 2 ..... **99/6**
Post Extra.

AMERICAN RECORDING TAPES

First grade quality American tapes. Brand new and guaranteed. Discounts for quantities.

3in.	200ft. L.P. mylar	4/-
3¼in.	600ft. T.P. mylar	10/-
5in.	600ft. std. plastic	8/6
5in.	900ft. L.P. acetate	10/-
5in.	1,200ft. D.P. mylar	15/-
5¾in.	1,200ft. L.P. acetate	12/6
5¾in.	1,800ft. D.P. mylar	22/6
7in.	1,200ft. std. mylar	12/6
7in.	1,800ft. L.P. acetate	15/-
7in.	1,800ft. L.P. mylar	20/-
7in.	2,400ft. D.P. mylar	25/-

Postage 2/-. Over £3 post paid.

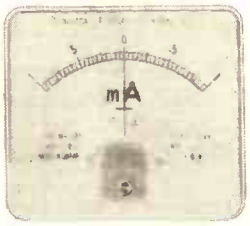
MINE DETECTOR No. 4A

Will detect all types of metals. Fully portable. Compact with instructions 39/6 each. Carr. 10/-. Battery 8/6 extra.

SEW PANEL METERS

MANUFACTURED BY SHINOHARA ELECTRICAL INSTRUMENTS LTD., JAPAN. FAMOUS ALL OVER THE WORLD FOR THE QUALITY, DEPENDABILITY AND ACCURACY OF THEIR INSTRUMENTS.
The comprehensive range below is available ex-stock. Other ranges to special order. Special quotations for quantities.

CLEAR PLASTIC METERS



Type MR.38P. 1 21 32in. square fronts.

50μA	32/6	750mA	22/6
100μA	29/6	1A D.C.	22/6
200μA	27/6	2A D.C.	22/6
500μA	25/-	5A D.C.	22/6
50-05-μA	29/6	3V D.C.	22/6
100-0-100μA	27/6	10V D.C.	22/6
500-0-500μA	22/6	20V D.C.	22/6
1-0-1mA	22/6	50V D.C.	22/6
1mA	22/6	100V D.C.	22/6
2mA	22/6	150V D.C.	22/6
5mA	22/6	300V D.C.	22/6
10mA	22/6	500V D.C.	22/6
50mA	22/6	750 V D.C.	22/6
100mA	22/6	15V A.C.	22/6
150mA	22/6	50V A.C.	22/6
200mA	22/6	150V D.C.	22/6
300mA	22/6	300V A.C.	22/6
500mA	22/6	500V A.C.	22/6
		'S' Meter 1mA	29/6

Type MR.52P. 2¾in. square fronts.

50μA	57/6	500μA	37/6
100μA	47/6	50-0-50μA	57/6

Type MR.52P. 2¾in. square fronts (Cont.)

100-0-100μA	47/6	300V A.C.	32/6
1mA	32/6	'S' Meter 1mA	39/6
5mA	32/6	*1A A.C.	32/6
10mA	32/6	*5A A.C.	32/6
100mA	32/6	*10A A.C.	32/6
1A D.C.	32/6	*20A A.C.	32/6
300V D.C.	32/6	*30A A.C.	32/6

Type MR.85P. 4¼in. × 4¼in. fronts.

50μA	69/6	3 amp. D.C.	45/-
100μA	59/6	15A D.C.	45/-
200μA	55/-	30A D.C.	45/-
500μA	49/6	*1A A.C.	45/-
50-0-50μA	69/6	*5A A.C.	45/-
100-0-100μA	59/6	*10A A.C.	45/-
500-0-500μA	49/6	*20A A.C.	45/-
1-0-1mA	45/-	*30A A.C.	45/-
1mA	45/-	50V D.C.	45/-
10mA	45/-	150V A.C.	45/-
50mA	45/-	300V D.C.	45/-
100mA	45/-	15V A.C.	45/-
1 amp. D.C.	45/-	300V A.C.	45/-

Type MR.65P. 3¾ × 3¼in. fronts.

50μA	59/6	50A D.C.	42/6
100μA	49/6	*1A A.C.	35/-
500μA	39/6	*5A A.C.	35/-
50-0-50μA	59/6	*10A A.C.	35/-
100-0-100μA	49/6	*20A A.C.	35/-
VU meter	59/6	*30A A.C.	35/-
1mA	35/-	10V D.C.	35/-
5mA	36/-	50V D.C.	35/-
10mA	35/-	150V D.C.	35/-
50mA	35/-	300V D.C.	35/-
100mA	35/-	15V A.C.	35/-
500mA	35/-	50V A.C.	35/-
1A D.C.	35/-	150V A.C.	35/-
5A D.C.	35/-	300V A.C.	35/-
15A D.C.	35/-	500V A.C.	35/-
30A D.C.	35/-		

BAKELITE PANEL METERS

Type MR.65. 3¾in. square fronts.

25μA	65/-	30A D.C.	29/6
50μA	42/6	50A D.C.	29/6
100μA	39/6	*1A A.C.	29/6
500μA	35/-	*5A A.C.	29/6
50-0-50μA	42/6	*10A A.C.	29/6
100-0-100μA	39/6	*30A A.C.	29/6
1-0-1mA	29/6	*50A A.C.	29/6
50mv.	39/6	10V D.C.	29/6
100mv.	39/6	50V D.C.	29/6
1mA.	29/6	150V D.C.	29/6
5mA.	29/6	300V D.C.	29/6
10mA.	29/6	*30V A.C.	29/6
50mA.	29/6	*50V A.C.	29/6
100mA.	29/6	*150V A.C.	29/6
500mA.	29/6	*300V A.C.	29/6
1A D.C.	29/6	300V A.C.	35/-
5A D.C.	29/6	VU Meter	49/6
15A D.C.	29/6		

*Moving iron, all others moving coil.

S.A.E. FOR ILLUSTRATED LEAFLET

MULTI-METERS

Brand New—Fully Guaranteed—Lowest ever prices.
Supplied with leads, batteries, instructions

MODEL PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000 v. A.C. and D.C. 0/1/100/500 MA. D.C. 0/100 kΩ. **39/6.** P. & P. 1/6.

MODEL 500. 30,000 O.P.V. 0/.5/1/2.5/10/25/100/250/500/1,000 V. D.C.
0/2.5/10/25/100/250/500/1,000 V. A.C.
0/50μA/5/50/500mA. 12 amp. D.C.
0/60/K6 Meg/60 Meg. Ω **£8/17/6.** Post paid.

MODEL TE-12 20,000 O.P.V. 0/.06/6/30/120/600/1,200/3,000/6,000 v. D.C. 0/6/30/120/600/1,200 v. A.C. 0/60μA/6/60/600 MA. 0/6K/600K/6 Meg./60 Meg. Ω. P.F.-.2 MFD. **£5/19/6.** P. & P. 2/6.

MODEL AR-620 20,000 O.P.V. 0/10/50/250/500/1,000 v. A.C. and D.C. 0/500μA/10/250mA. 0/10K/100K/1 Meg. Ω. 250 PF—.02 MFD. 0-500 Henrys **92/6.** P. & P. 2/6.

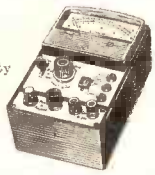
MODEL NH201 30,000 O.P.V. 0/.25/1/10/50/250/500/1,000 v. D.C. 0/10/50/250/500 v. A.C. 0/50μA/10/250 MA. 0/5/K500K/5 Meg. Ω **99/6.** P. & P. 2/6.

MODEL ITI-2. 20,000 O.P.V. 0/5/25/250/500/2,500 v. D.C. 0/10/50/500/1,000 V. A.C. 0/50μA/25/250 mA. D.C. 0/60K/6 Meg. Ω. .02-3 MFD. **82/6.** P. & P. 2/6.

MODEL NH-400 10,000 O.P.V. 0/.3/3/30/120/300/600/1,200 v. D.C. 0/12/60/120/300/1,200 v. A.C. 0/120 μA/30/300 MA. D.C. 0/2K/200K/2 Meg. Ω. 100 PF.—2 MFD. **79/6.** P. & P. 2/6.

MODEL 250J. 2,000 O.P.V. 0/10/50/500/2,500 V.D.C. 0/10/50/500/2,500 V.A.C. 0/2 Meg. Ω. 0/250 mA. —20 to +36 db. **49/6.** P.P. 2/6.

MODEL ZQM TRANSISTOR CHECKER



It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc.
Spec.: A: 0.7-0.9967.
B: 5-200.
Ico: 0-50 microamps, 0-5 mA.
Resistance for diode 200Ω —1 MEG. Supplied complete with instructions, battery and leads. **£6/19/6.** P. & P. 2/6.

PRECISION PORTABLE VOLTMETERS

Polished wood case. 8in. scale with knife edge pointer. A.C. and D.C. volts 0-160 volts, **59/6.** 0-160-32 **£5/19/6.** P.P. 3/6.

RCA MODEL 195-A VALVE VOLTMETERS

11 meg. inputs. 4in. 200μA meter. Six D.C. ranges: 3-1,000v. D.C. Five A.C. ranges: 10-1,000 v. A.C. Six OHM ranges: 1 K-1,000 megohms. 110/230 v. A.C. operation. Supplied brand new with instructions and test prods. **£7/19/6.** P. & P. 3/6.

CHASSIS PUNCH SET

Set of 5 popular size hole cutters, ⅝in., ¾in., ⅞in., 1in., 1⅛in. Supplied complete with punches, dies, T drive handle, tapered reamer, fitted leather case and instructions. **49/6.** P.P. 2/-

AUTO TRANSFORMERS

Step up or step down. Tapped 0/115/200/230/250 v. 20W. **9/-**; 60W. **12/6**; 75W. **15/6**; 150W. **18/6**; 200W. **27/6**; 300W. **42/6**; 500W. **67/6**; 1,000W., **90/-**; 1,500W. **£6/19/6**; 3,000W. **£7/10/-**; 7,500 W. **£15.**
(*Only tapped 0/110/230V.) Post extra.

PLUGS AND SOCKETS

Painton 15 pin in line printed circuit connectors. **7/6** pr. Large quantities available. Ditto 32 pin **12/6** pr.
PAINTON MINIATURE JONES. 4 pin **3/6** pr.; 6 pin **4/-** pr.; 8 pin **4/6** pr.; 12 pin **5/6** pr.; 18 pin **7/6** pr.; 24 pin **10/6** pr.; 33 pin **12/6** pr. Post extra.

TS-382 F/U AUDIO OSCILLATOR

High quality modern American instrument. Frequency coverage on 4 bands. 0-200 Kc/s. Output impedance 1,000Ω. Output monitoring meter. 7 range output attenuator from 12 microvolts to 12 volts. Operation 115 v. 50-1,000 CPS. Supplied as new. **£40.** Carr. 20/-.

NATIONAL H.R.O. DIALS

Brand new **27/6.** P.P. 1/6.

11FT. COLLAPSIBLE WHIP AERIALS

Brand new **8/6.** P.P. 2/-.

EMI WM5 CONSUL OSCILLOSCOPES

Available as new. Guaranteed perfect order. **£65**

HEADSETS

DLR5. Low imp.	10/6
W.S.88. Low imp. with rubber ear pads	17/6
Chamois padded moving coil	22/6
Ditto with microphone	25/-
S.F.20 High Imp.	11/6

All new. Post extra.

SILICON RECTIFIERS

250 P.I.V. 750 MA	3/-
400 v. P.I.V. 3 amp.	7/6
200 v. P.I.V. 6 amp.	5/6
1,000 v. P.I.V. 650 mA	7/6
800 v. P.I.V. 500 mA.	5/6
400 v. P.I.V. 500 mA.	3/6
200 v. P.I.V. 200 mA.	3/-
95 v. P.I.V. 3 amp.	5/6
70 v. P.I.V. 1 amp.	3/6
150 v. P.I.V. 165 mA.	1/-

Discounts for quantities. Post extra.

G. W. SMITH & CO.

3-34, LISLE STREET, LONDON, W.C.2

SEE OPPOSITE PAGE →

MODEL TE.18 GRID DIP METER

COMPLETE WITH ALL COILS FOR ALL FREQUENCY RANGES FROM 360 Kc/s to 220 Mc/s.

★ Compact—True one handed operation. ★ Covers 360 kc/s. to 220 Mc/s. ★ Functions as a Grid Dip Oscillator. Absorption wave meter and Oscillating Detector. ★ Completely wired—not a kit. The TE-18 can determine the resonant frequencies of tuned circuits, detect stray resonances in transmitters, check neutralization, etc. Frequency range 360 kc/s. to 220 Mc/s. in 8 accurately calibrated ranges. Grid current meter has a 500μA movement. Uses a 6AF4A valve, powered by a built-in transformer-operated power supply with selenium rectifier. For 220/240 v. A.C. 50-60 c/s. Size 7½in. H. × 2¾in. W. × 2in. D. **£12/10/-** Carr. 5/-.

AVO ELECTRONIC TEST METERS

Portable A.C. mains operation Valve Voltmeter. Eight D.C. volt ranges: 5 millivolt to 1,000 v. Twelve A.C. volt ranges: 100 millivolt to 2,500 v. Ten D.C. current ranges: .5μA to 1 amp. A.F. output: 5 milliwatts to 5 watts. Capacity: 100 pF.-50 mfd. Resistance: .2 ohm to 1,000 megohm. Guaranteed perfect working order. **£20.** Carr. 10/-.

NOMBREX EQUIPMENT

Transistorised Audio Generator 10-100,000 c/s. Sine or square wave. **£16/15/-.**
Transistorised Signal Generator 150 kc/s.-350 Mc/s. **£9/10/-.**
Transistorised resistance capacity bridge 1Ω-100 MegΩ, 1 pf.-100μF. **£8/5/-.**
Transistorised Induction bridge 1μH-100H. **£18.**
Mains Operated Transistor power supply unit, output 1-15 v. up to 100 mA. **£6/10/-.**
All above post paid with battery.

MAIN LONDON AGENTS FOR CODAR EQUIPMENT

PR.30 Preselector	£4	19	6
PR.30X Self powered	£7	4	0
RQ.10 "Q" Multiplier	£6	15	0
RQ.10X Self powered	£8	2	0
A.T.5 Amateur TX	£16	10	0
A.T.5. Mains P.S.U.	£8	0	0
A.T.5. 12 v. Transistor P.S.U.	£11	5	0
A.T.5. Remote control and Aerial Switching Unit	£2	7	6

Postage extra.

ILLUMINATED "S" METERS

Cal. in "S" units. 1mA basic 6 v. lamp, 1 21/32in. sq. front **29/6.** P. & P. 1/-. Ditto, 2 5/16in. sq. front, **39/6.** P. & P. 1/-.

DOUBLE BEAM C.R.T.'s

Cossor 89D	£2	19	6
Dumont K105 1PI	£2	19	6

Brand New. Post 3/6.

COLLARO/MAGNAVOX STUDIO TAPE TRANSCRIPTOR

Brand new, 3 speeds. 1⅞, 3¾, 7½ i.p.s. 3 motors, digital counter. Complete with instructions. 2 Track **£10/10/-**; 4 Track **£13/10/-.** Carr. paid.

TS-76 20,000 O.P.V. PUSH BUTTON MULTI-TESTER

Large clear plastic scale, simple operation. D.C. volts up to 1,000 v. A.C. volts up to 1,000 v. Resistance up to 10 megohm. Current up to 250 mA. Decibels −20 to +36 db. Size 6in. × 4 3/16in. × 2¼in. Complete with leads, batteries and instructions. **£5/5/-.** P. & P. 2/-.

BEST BUY!

Send 1/- P.O. for full Catalogue and Lists. Open 9 a.m. to 6 p.m. every day Monday to Saturday. Trade supplied.

STAR SR.40 COMMUNICATION RECEIVER

4 Bands 550 kc/s.-30 Mc/s. 'S' Meter-BFO-ANL-Bandspread Tuning—Built-in speaker. 200/250 v. A.C. Brand New **18½ GNS.**, carr. 10/-.

PART EXCHANGE WELCOMED

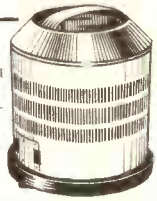
LAFAYETTE HA-63 COMMUNICATION RECEIVER

7 valves + Rectifier 4 Bands. 550 kc/s.-31 Mc/s. 'S' Meter-BFO-ANL-Bandspread Tuning 200/250 v. A.C. Brand New. **24 Gns.** Carr. paid.

LAFAYETTE HE-30 RECEIVERS

9 valves. 550 kc/s-30 Mc/s. Xemi kit form. **25 Gns.** Ready-built **33 gns.** Both carr. paid.

VOLTAGE STABILIZER TRANSFORMERS

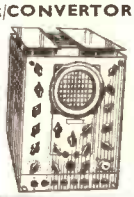


Will stabilize your mains voltage. Ideal for TV Receivers and Industrial equipment.

Input 80-120 v. and 160-240 v. Constant output 110 v. or 240 v. 250 watts. Brand new guaranteed **£10/10/-.** Carr. 7/6.

LAFAYETTE 'PRECON' AMATEUR PRESELECTOR/CONVERTOR

Convertor—20-15-10 metres. Preselector—80-40-20-15-10 metres. Crystal controlled—2 RF stages. 200-250 v. A.C. operation. Brand New **19 GNS.** Carr. 7/6.

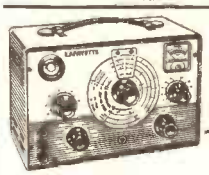


ERSKINE TYPE 13 DOUBLE BEAM OSCILLOSCOPES

Timebase 2 c/s.-750 kc/s. Separate Y1 and Y2 amplifiers. Up to 5.5 Mc/s. calib. at 100 kc/s. and 1 Mc/s. 110/230 v. A.C. Guaranteed perfect **£27/10/-.** carr. 20/-.

PROFESSIONAL 4-TRACK STEREO RECORD AND PLAYBACK TAPE DECK

Complete with 4 valve/4 transistor pre-amplifier. Will record and play back ¼ track stereo and ½ track mono at 7½ or 3¾ I.P.S. Twin meter level indicators, digital counter. Mic/gram/tuner inputs. Audio output 500 MW Bias and Erase 80 kc. Response 40-18,000 C.P.S. at 7½; 40-12,000 C.P.S. at 3¾ I.P.S. Motor 4 pole H.D. induction. Tape size up to 7in. 220/240 v. A.C. Size 15in. × 10½in. × 6½in. Line up: 4 × 28R173, 2 × 12AT7, 1 × 12AU7, 1 × 12BH7. S.A.E. FOR FULL DETAILS. **PRICE 42 GNS.** CARR. 15/-.



LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYSER

2 PF-2,000 MFD. 2 ohms-200 megohms. Also. checks impedance, turns ratio, insulation 200/250 v. A.C. Brand New **£15,** carr. 7/6.

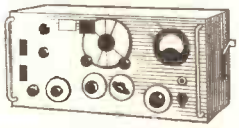
LAFAYETTE TE-20A R.F. SIGNAL GENERATOR

120 kc/s.-390 Mc/s. on 6 ranges. Variable R.F. and A.F. outputs. Large clear scale. Size 7½in. × 10¾in. × 4½in. 220/250 v. A.C. operation. Brand New **£12/19/6.** carr. 5/-.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20 cps to 200 kc/s. on 4 bands. Square 20 cps to 30 kc/s. Output impedance 5,000 ohms. 200/240 v. A.C. operation. Supplied Brand New and Guaranteed with instruction manual and leads. **£15.** Carr. 7/6.

MARCONI TF 144G/4 STANDARD SIGNAL GENERATOR



85 kc/s.-25 Mc/s. ± 1%. Output variable from 1 μV to 1 volt. Internal sine wave modulation 400 c/s. up to 75% depth. Operation 200/250 volt A.C. Offered in really excellent condition, like new, fully tested and guaranteed. **£25.** carr. 30/-.

G.E.C. BRT.402 RECEIVERS

A high grade 14 valve communication receiver covering 150-385 kc/s. and 510 kc/s to 30 Mc/s. in six bands. Special features include 2 RF stages, 'S' meter, Variable selectivity, B.F.O., ANL, AGC, 500 kc crystal calibrator, slide rule vernier dial with logging scale. Operation for 95-130 v. and 195-250 v. A.C. Output for phones, speaker or line. Offered in excellent condition, fully tested and guaranteed. **£60,** carr. 30/-.

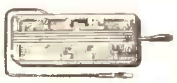
LAFAYETTE HI-FI STEREO HEAD-PHONES

★ Air cushioned headband
★ Soft rubber ear pads
★ Frequency response, 25 to 15,000 cycles. ★ High sensitivity. Impedance 8 ohms per phone. Supplied complete with all cables, wires, overload junction box and 3-connection plug. **82/6.** P. & P. 2/6.

MODEL DA-1 TRANSISTORISED FULLY AUTOMATIC ELECTRONIC KEYER

230V. A.C. or Battery operated. Incorporates built-in monitor oscillator, speaker and keying lever. Fully adjustable speeds giving either auto., semi auto., or hold. 7 transistors, 4 diodes, **£16/10/-.** P. & P. 4/6.

SEMI-AUTOMATIC "BUG"



Super speed key, 7 speed adjustments. 10WPM to as high as desired. Weight scale for reproductible settings. Precision tooled, anti-rust nickel plated brass and stainless steel operating parts. Size 6⅞in. × 3in. × 2¼in. Brand New. **£4/10/-.** P. & P. 2/6.

COSSOR 1035 DOUBLE BEAM OSCILLOSCOPES

3in. C.R.T. Calibrated Y1 Amplifier from 50 mV. to 50 v., bandwidth 10 Mc/s. Calibrated Y2 Amplifier from 5 v. to 500 v., bandwidth up to 100 kc/s. Directly calibrated X shift providing time measurement from 15μsec. to 150 millisecs. Supplied in guaranteed perfect working order. **£35.** Carr. 20/-. Also available COSSOR 1049 Double Beam Oscilloscope. **£40** each. Carr. 20/-.

ARMY FIELD TELEPHONES TYPE F

Generator Bell Ringing—2 line connection with wood carrying case. Fitted batteries. Supplied fully tested. **£4/19/6** pair, carr. 7/6.

VARIABLE VOLTAGE TRANSFORMERS

Brand New Guaranteed—Fully Shrouded. Input 230 v. 50/60 c/s. Output 0-260 v.

1 amp.	£4/10/-	20 amp.	£32/10/-
2.5 amp.	£5/17/6	2.5 amp. portable, metal case with meter-fuses, etc.	£9/17/6.
5 amp.	£9/10/-		
8 amp.	£4/10/-		
10 amp.	£16/10/-		
12 amp.	£18/15/-		

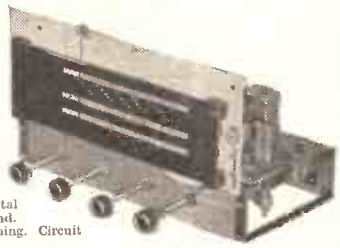
ALL MARTIN AUDIOKITS IN STOCK

ALSO SEE NEXT PAGE

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

7 VALVE AM/FM RADIOGRAM CHASSIS



Valve line-up ECC85, ECH81, EF89, EABC80, EL84, EM81, EZ80.

Three Waveband and Switched Gram positions. Med. 200-550 m. Long 1,000-2,000 m. VHF/FM 88-95 Mc/s. Phillips permeability tuning insert on FM and combined AM/FM IF transformers. Latest circuitry including AVC and Neg. Feedback. Three watt output. Sensitivity and reproduction of a very high standard. Chassis size 13½ × 6½in. Height 7¼in. Edge illuminated glass dial 11¼ × 3¼in. Vertical pointer. Horizontal station names. Gold on brown background. A.C. 200/250 v. operation. Magic-eye tuning. Circuit diagram now available.

Aligned and tested ready for use **£13 . 10 . 0** *Carr. & Ins. 7/6*

Complete with 4 Knobs—walnut or ivory to choice. Indoor FM aerial 3/6 extra. 3 ohm P.M. Speaker only required. Recommended Quality Speakers 10in. Rola 27/6. 12in. R.A. 30/-. 12in. R.A. with Tweeter, 42/6. E.M.I. 13½ × 8in., 37/6. Carr. 2/6.

CO-AX 80 ohm CABLE

High grade low loss Cellular Air Speed Polythene—¼in. diam. Stranded Cond.

Now only 6d. yard

BARGAIN PRICES—SPECIAL LENGTHS 20 yds. 9/-. P. & P. 1/6. Coax. Plugs 1/-. 40 yds. 17/6. P. & P. 2/-. Sockets 1/-. 60 yds. 25/-. P. & P. 3/-. Couplers 1/3.

NEW BOXED VALVES ALL GUARANTEED

IT4	3/6	EF86	8/6	PCL83	10/6
1R5, 1S5	6/-	EL33	12/6	PCL84	10/-
3S4, 3V4	7/-	EL34	12/6	PCL85	11/6
ECC81	7/-	EL84	7/-	PL36	10/6
ECC82	7/-	EY51	9/-	PL81	9/6
ECC83		EY86	9/-	PL83	8/-
ECL80	9/-	EZ81	7/-	PY33	10/6
ECL82	10/-	GZ32	9/6	PY82	7/-
ECL86	10/6	PCC84	8/-	U25	10/6
EF80	7/6	PCF80	8/-	UL84	9/-

TRIMMERS. Ceramic (Compression Type)—30 pF., 50 pF., 70 pF. 9d.; 100 pF., 150 pF., 1/3; 250 pF., 1/6; 600 pF. 1/9.

PHILIPS Bee Hive Type (conc. air spaced)—2-8 pF. 1/-; 30 pF 1/-.

METAL RECTIFIERS-STC. Types—RM1 4/9; RM2 6/6; RM3 7/6; RM4 16/-; RM5 21/-; RM4B 17/6; Mullard BY100 10/6.

JACK PLUGS—2½in. Igranic type 2/6; Screened ditto, 3/3; 1½in. Screened 2/3; Transistor type Min. and Sub.-min. 1/3.

JACK SOCKETS—Moulded Igranic type, open 3/6; ditto, closed 4/-. Pax. type open 2/6; ditto, closed 3/-. Transistor type, closed, Min. and Sub.-min. 1/6.

PHONO PLUGS 9d. Phono Sockets (open), 9d. Ditto (closed), 1/-. Twin Phono Sockets (open). 1/3.

GRUNDIG CONTINENTAL. 3 p. or 5 p. plug, 3/6. Sockets, 1/6.

WAVECHANGE SWITCHES. 1 p. 12-way, 2 p. 2-way, 2 p. 6-way, 3 p. 4-way, 4 p. 2-way, 4 p. 3-way, long spindle, 3/6 each.

STYLUS REPLACEMENTS. Diamond Styli for L.P. or Stereo, for all pop. types, BSR, Collaro, Garrard, etc., 11/3 ea. Gtd. 12 mths. SAPPHIRE ditto, 5/3 ea. Comp. range in stock.

TRANSISTOR COMPONENTS

Midget I.F.'s—465 Kc/s. $\frac{9}{16}$in. diam. 5/6
Osc. Coil M/W. $\frac{9}{16}$in. dia..... 5/3
Osc. Coil M. & L.W..... 5/9
Midget Driver Trans. 3.5 : 1 6/9
Midget Output Trans. Push Pull—3 ohms 6/9

Elec. Condensers—Midget Type 1 mfd., 50 mfd. ea. 1/9, 100 mfd. 2/-. 12 v. wkg.

Condensers 150 v. working: .01 mfd., .02 mfd., .03 mfd., .04 mfd. 9d.; .05 mfd., .1 mfd. 1/-; .25 mfd. 1/3; .5 mfd. 1/6, etc.

Midget Tuning Condensers. J.B. "OO" 208 pf. and 176 pf. 8/6; ditto with trimmers 9/6. JB 220 pf. and 105 pf. conc. slow motion 10/6. 363 pf. single 7/6. Sub. Min. ¾in. Dilemin 100 pf., 300 pf., 500 pf. 7/- each.

FERRITE AERIALS. M. & L.W. car aerial coil 9/3.

Midget Vol. Control with edge control knob. 4 K/ohms, with switch, 4/9. Ditto less switch 3/9.

Speakers: P.M.: 2in. Plessey 75 ohms 15/6. 2½in. Continental 8 ohms 13/6. 7 × 4in. Plessey 35 ohms 23/6. 2½in. Continental 8 ohms 13/6.

SOLDERING IRONS. Mains 200/220 v. or 230/250 v. Solon 25 watt Inst., 22/6. Spare Elements, 4/6. Bits, 1/-. 65 watt, 27/6, etc.

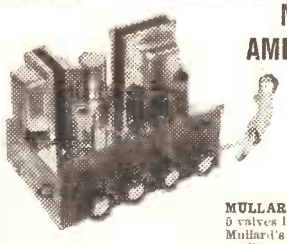
ALUMIN. CHASSIS. 18g. Plain Undrilled, folded 4 sides, 2in. deep, 6in. × 4in., 4/6; 8in. × 6in., 5/9; 10in. × 7in., 6/9; 12in. × 6in., 7/6; 12in. × 8in., 8/-, etc.

ALUMIN. SHEET. 18g. 6in. × 6in., 1/-; 6in. × 9in., 1/6; 6in. × 12in., 2/-; 12in. × 12in., 4/6, etc.

6 VALVE AM-FM TUNER UNIT

Med. and VHF 190 m.-550 m., 85 Mc/s.-103 Mc/s., 6 valves and metal rectifier. Self-contained power unit, A.C. 200/250 v. operation. Magic-eye indicator, 3 push-button controls, on/off, Med., VHF. Diode and high outputs ockets with gain control. Illuminated 2-col. perspex dial 11½ x 4in. Chassis size 11⅝ x 4 x 5¾in. A recommended Fidelity Unit for use with Mullard "3-3" or "5-10" Amplifiers. Available only at present as built-up units, aligned and tested ready for use. **Bargain Price £12/10/-.** Carr. 5/-. **We hope to produce this popular unit in kit form very shortly.**

MULLARD "3-3" HI-FI AMPLIFIER, 3 VALVES 3 WATT



3 ohm and 15 ohm Output. Hi-Fi quality at reasonable cost. Bass Boost and Treble controls, quality sectional output transformer, 40 c/s-25 kc/s. ±1 dB. 100 mV. for 3W., less than 1% distortion. Bronze escutcheon panel. Power take-off available. **Complete Kit only £6/19/6.** Carr. 5/-. **Wired and tested 8 gns.**

MULLARD "5-10" AMPLIFIER
5 valves 10W. 3 and 15 ohms output. Mullard's famous circuit with heavy duty ultra-linear quality output transformer. Basic amplifier kit price £9/19/6. Carr. & Ins. 7/6. Ready Built 11½ Gns.

CONTROL PANEL KIT
Bass, Treble and Volume control with 4-position selector switch for radio, tape and p.u. and 11in. × 4in. escutcheon panel.
Amplifier Kit and Control Panel Kit £11/19/6. Ditto ready wired £14/19/6.

2-VALVE PRE-AMP. UNIT
Based on Mullard's famous 2-valve (2 × EF86) circuit with full equalisation, with volume, bass, treble, and 5-position selector switch. Size 9in. × 6in. × 2½in.
Complete Kit £5/19/6. Carr. 3/6. **Ready built £7/19/6.**

ANOTHER TAPE RECORDER BARGAIN

Manufacturers end of production Surplus Offer

A 24 gn. Tape Recorder offered at the bargain price of only 15 gns. plus 10/- carr. Supplied in 3 Units already wired and tested. A modern Circuit for quality recording from Mike, Gram or Radio, using latest B.S.R. Twin Track Monar-deck Type TD2. Valve line-up—EF86, ECL82, EM84, EZ80 and Selenium Diode. Send for detailed list—3d. stamp.

Complete Kit comprising items below.

BARGAIN PRICE 15 Gns. +10/- Carr.

2-tone Cabinet and 8in. × 5in. Speaker. Size 14in. × 10in. × 7½in.	£3 10 0+	5/-	Carr.
Wired Amplifier complete with 4 Valves, front Panel, Knobs, etc.	£5 12 6+	3/6	Carr.
B.S.R. Monardeck Type TD2	£7 7 0+	4/6	Carr.
Accessories: Mike, Tape, empty Reel, screened Lead and Plugs, Instructions, etc.	£1 0 0+	2/-	Carr.

We manufacture all types Radio Mains, Transf. chokes, Quality O/P. Trans., etc. Enquiries invited for specials, prototypes for small producton runs. Quotation by return.

RECORDING TAPE

Famous American Columbia (CBS) Premier quality tape at NEW REDUCED PRICES. A genuine recommended Quality Tape—TRY IT Brand new, boxed and fully guaranteed. Fitted with leader and stop foils.

Standard			Double Play		
5in.	600ft.	13/-	1,200ft.		31/6
5¾in.	900ft.	16/-	1,800ft.		37/6
7in.	1,200ft.	21/-	2,400ft.		47/6
Long Play			Post & Pack per		
5in.	900ft.	17/6	reel, 1/- plus 6d.		
5¾in.	1,200ft.	19/6	ea. for additional		
7in.	1,800ft.	28/6	reels.		

SPECIAL OFFER. 3in. Message tape 150ft. 3/9; 3in. L.P. 225ft. 4/9; 3in. D.P. 300ft. 6/6; P. & P. per reel 6d.

TAPE REELS. Mnfrs.' surplus 7in. 2/3; 5¾in. 2/-; 5in. 2/-; 3in. 1/3; Plastic spool containers, 5in. 1/9; 5¾in. 2/-; 7in. 2/3.

SPEAKERS P.M. 3 ohms. 2½in. EMI, 15/6. 3in. Goodmans 16/6. 5in. Rola 15/6. 6in. Elac 16/6. 7 × 4in. Goodmans 15/6. 8in. Rola 19/6. 10in. Elac 25/-. 10 × 6in. Goodmans 22/6. 2½in. E.M.I. Tweeter, 22/6. 13½in. × 8in. E.M.I. (Ceramic Magnet), 37/6.

ENAMELLED COPPER WIRE—¼lb. reels 14g-20g 2/6; 22g-28g, 3/-; 30g-34g, 3/9; 30g-38g, 4/3; 39g-40g, 4/6, etc.

TINNED COPPER WIRE 16-22g., 2/6 ½lb.

VALVE HOLDERS—Int. Oct. 6d. Nylon or Ceramic, B7G, B9A unskirted, 9d. B7G B9A skirted 1/- each; B7G with Can 1/6; B9A with Can, 1/9, etc.

KNOBS—Modern Continental types:—Brown or Ivory with Gold Ring. 1in. dia. 9d. ea. 1¾in. 1/- ea. Brown or Ivory with Gold Centre, 1in. dia. 10d. each; 1¾in. 1/3 each. LARGE SELECTION AVAILABLE.

TYGAN FRET (Contem. pat.) 12 × 12in. 2/-; 12 × 18in. 3/-; 12 × 24in. 4/-, etc.

BONDACOUST Speaker Cabinet Acoustic Wadding, approx. 1in. thick. 18in. wide, any length cut 2/3 ft. 6/- yd. **EXPANDED ANODIZED METAL.** Attractive gilt finish, ¼ × ¼in. diamond mesh 4/6 sq. ft. Multiples of 6in. cut. Max. size 4ft. × 3ft. 47/6 plus carr.

JASON F.M. TUNER UNITS

Designer-approved kits available.
FMT1. 5 gns. 4 valves 20/-.
FMT2. £7. 5 valves 35/-.
JTV Mercury, 10 gns. 3 valves 22/6.
JTV2. £13/19/6. 4 valves 28/6.
NEW JASON F.M. HANDBOOK 2/6.
48 hr. Alignment Services, 7/6 plus 2/6.

CONDENSERS—Silver Mica. All values, 2 pf. to 1,000 pf., 6d. each. Ditto ceramics 9d. Tub. 450 v. T.C.C., etc. .001 mfd., .01 and .1/350 v. 9d. .02-1/500 v., 1/-. .25 Hunts 1/6. .5 T.C.C. 1/9 etc., etc.

CLOSE TOL. S/MICAS, 10% 5 pf.-500 pf. 8d. 600-5,000 pf. 1/-. 1% 2 pf.-100 pf. 9d. 100 pf.-500 pf. 11d. 575 pf.-5,000 pf. 1/6.

RESISTORS—Modern ratings full range 10 ohms to 10 megohms. 20% ¼-½ w. 3d. ea., ditto 1 w. 6d. ea., 2 w. 9d. ea., 10% ¼-½ w. 4d. ea., 5% Hi-stab, ¼-½ w. 6d. ea. (below 100 ohms and over 1 meg. 9d. ea.). 1% Hi-stab., ½ w. 1/6 ea. (below 100 ohms 2/- ea.).

WIREWOUND. 25 ohms to 10K. 5 w. 1/3. 10 w. 1/6. 15 w. 2/-.

PRE-SET T/V POTS. W/W 25 ohms-50K, 3/-. 50 K. 2 Meg. (Carbon), 3/-.

Electrolytics All Types New Stock

TUBULAR		CAN TYPES	
25/25v. 50/12v.	1/9	8+8/450 v.	4/6
50/50v. 100/25v.	2/-	32+32/275v.	4/6
8/450v. 4/350v.	2/3	50+50/350v.	6/6
16/60/450 v.	5/6	60+250/275v.	17/6
32/32/450 v.	6/6	100+300/275v	12/6

Transistor Midge types—all values 1 mfd. to 50 mfd. 1/9 ea. 100 mfd. 2/-, 12 v.

VOLUME CONTROLS—5K—2 Meg. ohms. 3in. SPINDLES, MORGANITE MIDGET TYPE. 1¼in. dia. Guar. 1 year. LOG or LIN. ratios, less Sw. 3/-. D.P. Sw. 4/6. Twin Stereo less Sw. 6/6. Some values with DP Sw. 8/6.

DE-LUXE RECORD PLAYER KIT

Incorporating 4 Sp. Garrard Auto-Slim unit and Mullard latest 3 watt printed circuit amplifier (ECL86 and EZ80), vol., bass and treble controls, with 8 x 5in. 10,000 line speaker. Contemporary styled two-tone cabinet, charcoal grey and off-white with matching blue relief. Size 17½in. x 16in. x 8in. A stylish unit capable of quality reproduction. Circuit and const. details 2/6 (free with kit).

COMPLETE KIT Carr. and ins. 10/-. **£13.19.6**

Illuminated Perspec control panel escutcheon 7/6 extra. Ready wired 30/- extra. 4 contemporary mounting legs (6 or 13in.), 12/6 per set.

Only a few items are listed from our comprehensive stock. Write now for full bargain lists, 3d.

Terms: C.W.O. or C.O.D. post and packing ½lb. 9d., 1lb. 1/3, 3lb. 2/3, 5lb. 2/9, 10lb. 3/9, etc.

T S RADIO COMPONENT SPECIALISTS *Established 1946*

70 BRIGSTOCK RD., THORNTON HEATH, SURREY
Tel.: THO 2188: Hours 9 a.m.—6 p.m. 1 p.m. Wednesday.

IMMEDIATE DELIVERY

ALL ITEMS FULLY GUARANTEED

AC/DC VALVE VOLTMETER

Latest circuitry provides perfect stability and sensitivity.

Professionally acknowledged.

Just Look at this specification !

★11 megohms per volt.
★5mV-1,500 V. A.C.
★100 mV-1,500 V. D.C.
★0.1 ohm—1,000 Megohms

PLUS

★1 Kc Oscillator Test Source
★Complete with Test Probe with BUILT-IN A.C./D.C. switch, no fumbling or fiddling with out of reach knobs.

This superbly finished instrument is invaluable in Production depts. and Labs. and is presented in an attractive light grey crackle steel case with satin alloy front.
Mains operated.
Size and weight: 5½in. x 3in. x 8in. high. 5½lb.

Price ONLY **£35.0.0** —no extras.

VARIABLE VOLTAGE TRANSFORMERS

World famous "SLIDUP"

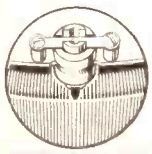
Model SB10 10 amp.

Inset shows latest type brush gear providing 1 volt variation.

★ *RATED CURRENT CONSISTENT AT ALL POINTS ALONG THE WINDING.*

Output: 0-260 v. Input: 230 v. A.C. 50/60~.

Shrouded fully variable transformers for bench or panel mounting.



2.5 Amp.	£5.17.6
5 Amp.	£9. 0.0
10 Amp.	£18. 5.0
20 Amp.	£32.10.0

Ex. works.
Carr. & Pkg. EXTRA

CONSTANT VOLTAGE TRANSFORMER

AUTOMATIC MAINS STABILIZER

Complete with lead and plug, in attractive silver hammer metal case with handle.

PROVIDES PERFECTLY STABILIZED CONSTANT VOLTAGE FOR ALL LABORATORY EQUIPMENT.

★ NO MOVING PARTS ★ NO MAINTENANCE.
★ NO ATTENTION.

SPEC.: INPUT: 240 v. A.C. ±20%
OUTPUT: 240 v. A.C.—50 cycles.
CAPACITY: 250 VA.
ACCURACY: ±1½%. Size 10 x 5 x 7in. high.

Weight 21 lbs. Fitted signal lamp and switch.

£11.10.0 Carr. & Pkg. 20/-.

PORTABLE VARIABLE A.C. POWER SUPPLY UNIT

DESIGNED FOR ENGINEERS WHOSE REQUIREMENTS CALL FOR A VISUAL INDICATION OF VOLTS APPLIED.

OUTPUT: 0-260 v. 1½ amps.

INPUT: 230 v. A.C. 50/60~. Unit fitted with fuse, voltmeter, safety indicator, on-off switch and lead. Size: 8 x 5 x 5in. high.

PRICE **£8.10.0** Carr. & Pkg. 10/-

LATEST miniature '88' Set WALKIE TALKIE

Produced to exacting specifications by leading manufacturers E. K. Cole & Co.

Only **£10.0.0** EACH

This Transmitter /Receiver weighs only 5½lb.(appx.) and measures 3½ x 5½ x 9½in.

A crystal controlled 4 frequency set operates from standard dry battery—H.T./L.T. (i.e. Vidor L5537), 14 current series B7G valves used.

SUPPLIED COMPLETE WITH VALVES & CRYSTALS
Details & Prices of all Accessories supplied on request.

TRANSISTOR TESTER

Model AT—1 **£10.10.0** Carr. & Pkg. 7/6

FULLY PORTABLE PRECISION INSTRUMENT

MEASUREMENT RANGES:

Ico (Icbo) and the reverse current of diodes.

PNP & NPN—C~50μA (1μA per scale).

POWER—0~ 1mA (20μA per scale).

β5-200 (5 per scale).

Bias Current—
(1mA on PNP & NPN)
(5mA on POWER)

α0.9-0.995 (from $\beta \frac{\alpha}{1-\alpha}$)

Terminals: Spring Sockets and Screw Terminals.

Meter: 4in. 50μA moving coil.

Size and Weight: 7 x 5 x 3in. 2½lb.

Powered by pen cells.

VARIABLE HIGH-VOLTAGE UNIT

DIELECTRIC BREAKDOWN TESTER

★ *Range:* Infinitely variable up to 3,000 volts and can be accurately set. 0.1 amp.
★ Entirely suitable for continuous testing.
★ Built-in Automatic safety cut-out.

Input: Mains voltage.
Robustly constructed for bench use with 4½in. x 4in. modern styled meter, placed at an easy to read angle. Complete with input and test leads with clips.
Model T30, 0-3,000 v. A.C. £32.

TRANSISTORISED MEGOHMMETER

★ NO WINDING !
★ PUSH BUTTON TO READ

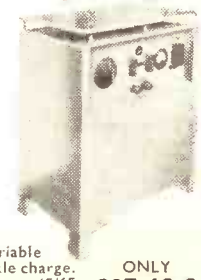
500V.-1,000 MEGOHMS

Portable, supplied c/w batteries, probes and carrying case. Superb instrument.

ONLY **£23.10.0** Carr. & Pkg. 7/6

Also: 500 v.-500 Megohms mains operated insulation tester. Designed for continuous use. £26-5-0.

20AMP 24VOLTS HEAVY DUTY SUPPLY UNIT



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Essential equipment for Electronic Engineering. Research Laboratories, Schools. Ideal for battery charging, etc. Guaranteed for 20 amps.

Output: 24 v. D.C. variable up to 20 amps. and trickle charge.
Input: A.C. 100/260 v. 45/65 cycles. Input and output fully used.
Size: 16 x 24 x 32in. high. In heavy gauge steel grey cabinet.

ONLY **£27.10.0** Packing & Carr. 40/-.

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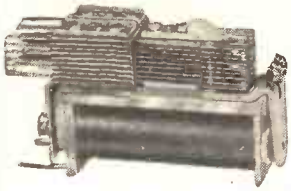

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OVER 120 TYPES IN STOCK. SEND FOR LIST.

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2.2Ω+2.2Ω		H96A	18/6
50Ω+50Ω		H96B	19/6
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2,500Ω	4CO	M1008	19/6
2,500Ω	1CO	M1022	15/-
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670Ω	2m2bHD	M1095	17/6
2,500Ω	2C2K	M1417	19/6
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2Ω	2mHD	M1454	15/-
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40Ω	2CO2K	M1482	19/6
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670Ω	4K	M1567	19/6

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45Ω	1mHD	4186EB	19/6
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2,500Ω	2CO	4184GE	19/6
2,500Ω	1mHD	4190EE	19/6
ERICSSON			
7,000Ω	1CO	N22242A10	25/-
260Ω	1CO	N22372AC1	15/-
5,000Ω	1CO	N22372AE1	15/-
7,500Ω	2CO	N22365AZ1	17/6
1.1Ω	4CO	N22364AA1	19/6
1.1Ω	2CO2K	N22366AA1	19/6
1,500Ω	2CO2K	N22366AE1	19/6
2.4Ω	2M	N22371AA1	15/-
180Ω	2M	N22371AC1	15/-
2,000Ω	2M	N22371AE1	15/-
2.4Ω	1m1b	N22370AA1	15/-
52Ω	1m1b	N22370AB1	15/-
1,500Ω	2m2b	N22369AE1	17/6
7,500Ω	2m2b	N22369AZ1	17/6

S.T.C. POLARIZED RELAY 4192B. Coil 4×550Ω with jack, **50/-.**
MINIATURE UNISELECTORS. Plug-in type. Occupies no more space than a P.O. 3000 Relay. Siemens No. 2200A, 3 level, 12 outlets, 50 volts, 1 bridging and 2 non-bridging wipers. Supplied complete with jack. EACH 90/-
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RELAYS 24 volt D.C. 4 Make, 4 Break 10 amp. 5C/3944 Dust cover. **12/6** each.

KEY SWITCHES (3 position).
P.O. 212 2C/2C Locking **6/6.**
P.O. 264 2K/2K Locking **9/-.**
4C/4C Non locking **13/6.**
P.O. 295 4C/6C NL/L **17/6.**
Other types available. Knobs **6d.** Plates **1/-.**

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SINGLE-POLE Double Throw, 3 amp. 250 A.C.
Can be used as ON/OFF or CHANGE-OVER SWITCH.

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12 Volts 1 Amp.	7/6 each	24 Volts 1 Amp.	12/6 each
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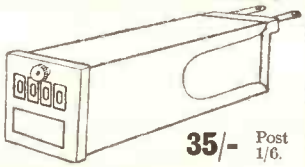

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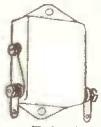

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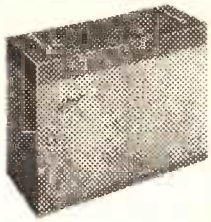
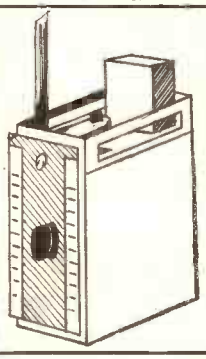


Attractive two-tone finished speaker cabinets, size 28in. × 20in. × 10½in. Will take two 12in. loudspeakers. Excellent acoustic properties. Ideal for home use, group or P.A. work. Price **10** gns. each, p/p 10/-. B.R.S.



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Perforated cover with carrying handles can be provided if required, price 21/-.

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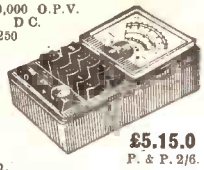

Push button, 20,000 O.P.V. Test Meter. D.C. Volts: 0-1-10-50-250-500-1,000. A.C. Volts: 0-10 - 50 - 250 - 500 - 1,000 D.C. Current: 0-50 mA., 10 mA. 50 mA. Resistance: 0-5 kΩ-500 kΩ-5 MΩ. Inductance: 50 H.—5,000 H. Capacitance: 150 pF.-0.02 μF. D.B.: −20Ω +22 D.B., 20Ω 36 D.B.

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£7.19.0 P. & P. 3/-.

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4,000 O.P.V. on Both A.C. and D.C.
D.C. Volts 0—5—25—125—500—2,500.
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D.C. Current 0—250μA—0—250 mA.
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Meter size 4½in. × 3¼in. × 1½in.
Complete with test prods and battery.
Wonderful Value at 63/- + 3/- P & P.

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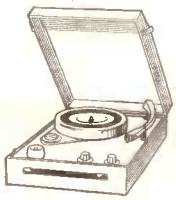

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Freq. Res. 30-12,000 c/s. Sensitivity 180 mV./cm./sec. Load 1 MΩ 100 pF. Complete with Sapphire Stylus.
Our Price **12/6** ea. P. & P. 1/-.

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With 2 Sapphire Stylus.
Our Price **19/6** ea. P. & P. 1/-.

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Die-cast, hand shaped body. Special offer. **15/6** plus P. & P. 2/6.

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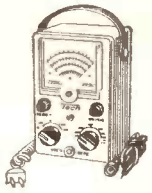
For use with any type tape recorder, wonderful value, **5/9**. Post paid.

TECH. MODEL PV-58 VACUUM TUBE VOLTMETER



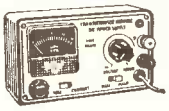
Finest design for stable and accurate measurement. 1% tolerance on all resistors. Large design 4in. 200 a. meter for accurate readings 11 megohm input.

Ranges:
−D.C.V. 0-1.5-5-15-50-150-500-1,500 v.
+D.C.V. 0-1.5-5-15-50-150-500-1,500 v.
A.C.V. 0-1.5-5-15-50-150-500-1,500 v. R.M.S.
0-1.4-4-14-40-140-400-1,400-4000 P.P.

Resistance: 2 ohms to 1,000 megohm.
Decibels: −10 db. to +65 db.
Operation: 220/240 v. A.C. Size 7in. × 4¾in. × 4in.
Each tester is supplied brand new and fully guaranteed complete with probe and operating instructions.

The finest value in tester available at only **£12/19/6** Complete. P. & P. 3/6 ex.

EECO MODEL S.E.100 TRANSISTORIZED VARIABLE D.C. POWER SUPPLY



METER RANGES
Volt., 0-20 V.D.C.
Current 0-20 mA.
0-200 mA.

Voltage Range
0-20 volts.
Continuously variable.

Maximum Current Cap.: 0-10 v. 200 mA. Intermittent. 0-20 v. 150 mA. continuously.
Impedance Source: Current position. 3.3 ohms. Voltage position 0.2 ohms.
Power Input: 220/240 v. Size 6in. × 3¾in. × 2¾in.
Fuse: 0.5 amp., slow blow, in D.C. circuit.
The extremely wide variable voltage range, low A.C. ripple and source impedance of the S.E.100 makes it a most satisfactory power supply to operate transistor radios, hearing aids, pre-amplifiers, instruments and other electronic devices under repair. The S.E.100 can be used in television and radio servicing, as an A.V.C. or A.G.C. voltage source as a D.C. filament supply, operate relays, recharge small batteries and light electro plating as in dentistry.

£6/10/0 P. & P. 4/6. Fully guaranteed and complete with test lead, croc. clips and operating instructions.

EECO MODEL S.E.200 MINI-LAB TESTER

This remarkable meter has seven test instruments packed into one pocket size case which can be taken and used anywhere. *Resistance Substitution.* 100Ω, 1KΩ, 10KΩ, 100KΩ 1MΩ. *Capacitance Substitution.* .002 mfd.-.005 mfd., .02 mfd.; 1 mfd. and 10 mfd. *R.F. Signal Generator.* Frequency fixed at 445 Kc/s. (adjustable to 700 Kc/s.), output 35 mV. approx. *Audio Generator.* Frequency 400 c/s. Output 35 mV. approx. *D.C. and A.C. Volts.* 4 ranges. 0-15-50-150-500 volts at 4,000 O.P.V. *R.F. Field Strength Indicator.* Frequency range 1 to 140 Mc/s. Antenna 5 sections length 10¾in. Size 6in. × 2¾in. × 3¾in. The Mini Lab. is completely battery operated and suitable for quick checks in the service shop and Home Service calls. **£8/19/6** each. Complete with Test Prods and Battery, fully guaranteed.

EECO MODEL MS4 FLOORSTAND

Height fully open 55½in. Fully closed 33in. Three sections, fully telescopic. ⅜in. or ⅝in. mic. adaptor.

39/6 ea. P. & P. 5/-.

Heavy cast iron base. Wonderful value.

NEW!!! NEW!!!

CM61—High Impedance Crystal Mic. with built-in on/off Switch. Complete with Table Stand, Plug-in Mic. lead and neck Holder all in a wonderful Satin Chrome Finish.

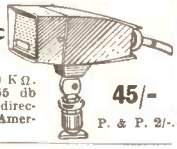
★VALUE AT 33/6 + 1/9 P. & P.

ELAC SPEAKER OFFER

5in. Speaker	8/6
6in. Speaker	11/-
8in. Speaker	11/-
7in. × 4in. Speaker	10/-
5in. Rola Celestion	9/6

P. & P. 3/-.

MD 175 DYNAMIC MIC.



Impedance 50 KΩ. Sensitivity: 55 db at 1,000, non-directional, latest American design.

45/- P. & P. 2/-.

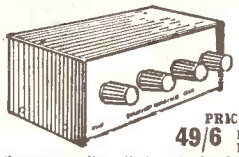
EECO MODEL UD801 UNI-DIRECTIONAL DYNAMIC MICROPHONE DUAL IMPEDANCE (600Ω, 50 kΩ)

Frequency Characteristics. 100Ω 14,000 c/s., 15 db.
Sensitivity. −75db ± 3db at 600Ω. −55 db ± 3db at 50 kΩ 0db = 1 v./μ bar.
Directionality. Uni-directional (50Ω 7,000 c/s. over 15 db at 180°). This is a new and high class dynamic uni-directional microphone very high in sensitivity and excellent in frequency characteristics, maintains high stability even against poor ambient conditions. **£9/10/0** P. & P. 3/6. Complete with 12ft. twin screened mic. cable, fully guaranteed.

SUN ACE 4 Ready built 4 transistor new push button

Super de-luxe Tape Recorder. Circuit —4 transistors. Recording D.C. bias ¼-track, built-in 2½in. p.m. speaker. Recording time 17 mins. approx. on 200ft. tape. Batteries 1U 2-1 PP3. Complete with crystal microphone—personal earphone. 200ft. Tape and reel. Spare spool. Carrying strap and Batteries. Wonderful value at only £4/15/- plus 4/9 P. & P. (Fully guaranteed).

EECO 4-Channel Transistorized MICROPHONE MIXER



PRICE **49/6** post paid.

Give all your recordings that professional touch. The Eeco mixer allows you to mix 4 signals such as Mic., tape, records and tuner into a single output. Wonderful for groups, amateur recorders, etc.
Guaranteed to give hours of pleasure.

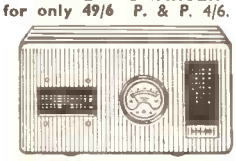
FAMOUS MAKE AMPS AND PRE-AMPS at Vastly Reduced Prices

3-4 watts, £4/19/-; 4-5 watts, £5/13/6; 5/5 Stereo. £11/16/3; 10 watts, with separate pre-amp., £15/2/6; 30 watts, £15/2/6; 50 watts, £16/2/6; Tremolo unit, £3/15/9; tape pre-amp., £9.

Miniature Push-Pull Audio AMPLIFIER

4-transistor, output 200 m.w., low and high gain, inputs to operate 3Ω speaker. Wonderful value, 31/6. P. & P. 2/-. Complete with operating instructions.

A GENUINE 4-AMP. BATTERY CHARGER for only 49/6 P. & P. 4/6.

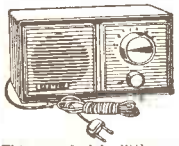


Made in England to our own specification and fully guaranteed.
High-Low-Med. Change Rate. 6 v. or 12 v. Selector Plug. 200/50 v. Mains Selector Plug. 4 amp. cartridge fuse protection, complete with mains lead, charging lead and croc. clips.

Personal Callers Only RECORD PLAYERS

The Very latest Super Slim Line Autochanger Record Player. Built and ready to go. Incorporating the New B.S.R. UA25 Super Slim Deck in the latest design cabinet. 2½ watt output with tone and Volume Controls.
Fully Guaranteed 11 Gns.

VANTONE MAINS RADIOS

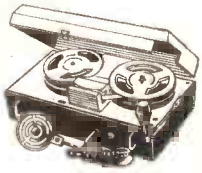


Ready built 5-valve superhet with built-in Ferrite tuning bar.

£3/15/- Plus P. & P. 3/9. Fully guaranteed.

This wonderful little radio will receive all stations on med./wave loud and clear inc. Luxembourg. Ideal for bedrooms, kitchens, or as a second mains radio.

EHRECORDER



Ready built 4 Transistor Tape Recorder. Easy to operate single lever function control. 200 mW. output complete with microphone —3in. Tape—Spare Spool — Personal earpiece and batteries. Wonderful Value £4/19/6 plus 5/- P. & P.

The Silver Ribbon 625 INDOOR AERIAL

Also for 405-ITV —BBC and F.M. Complete with co-ax. plug. **19/6** P. & P. 1/-.

LASKY'S RADIO

For The Finest Value a

THE HOME OF HI-FIDELITY

COMPLETE MONO/STEREO SYSTEMS TO YOUR SPECIFICATION AT LASKY'S SUPER PRIVILEGE PARCEL PRICES

DEMONSTRATION STUDIOS

Hear and compare the very latest

HI-FI EQUIPMENT

Visit our spacious showrooms at 33 Tottenham Court Road, 207 Edgware Road or 152-3 Fleet Street, whichever is most convenient. In our Demonstration Studios you can see, examine, hear and compare the very latest products in the realm of high-fidelity reproduction.

● TAPE RECORDERS ● TAPE DECKS ● MICROPHONES ● AMPLIFIERS ● CONTROL UNITS ● AM/FM TUNERS ● RECORD PLAYERS ● AUTOCHANGERS ● TRANSCRIPTION TURNTABLES ● PICK-UPS ● LOUDSPEAKERS ● SPEAKER SYSTEMS ● CABINETS AND ENCLOSURES ● TRANSISTOR RADIOS.

by all the well-known makes including:—

ARMSTRONG	G.E.C.	LORENZ	STELLA
BRENELL	GOLDRING	LOWTHER	STUZZI
CHAPMAN	GOODMANS	LUSTRAPHONE	TANDBERG
COLLARO	GRUNDIG	ORTOFON	TANNOY
CONNOISSEUR	HARTING	PAMPHONIC	TELEFUNKEN
COSSOR	H.M.V.	PHILIPS	THORENS
DULCI	JASON	QUAD	TRUVOX
E.A.R.	KORTING	RESLO	VORTEXION
ELIZABETHAN	LEAK	ROGERS	W.B.
FERROGRAPH	LENCO	SIMON	WEARITE
FI-CHORD	LINEAR	SOUND	WHARFEDALE
GARRARD			

If you cannot pay us a visit please send us details of your choice of equipment and we shall be pleased to quote. See Complete Systems.

COMPLETE SYSTEMS

A **Lasky's "Privilege Parcel"** allows you to purchase the Audio System of your choice at a worth-while cash saving. We shall be pleased to quote our "Privilege Parcel" Prices for any selection of equipment of your own choice. Send us details of your requirements. **H.P. Terms can be arranged on Privilege Parcels.**

RECORD PLAYERS

4-SPEED AUTO-CHANGERS

B.S.R. AUTOCHANGERS AT LOWEST EVER PRICES!

All brand new and fully guaranteed complete with cartridge and stylus.

UA16 4-speed mains model	£4 19 6
UA20 4-speed	£5 19 6

Add 5/- P. & P. on each.

GARRARD

Auto-Slim Mono	£6 10 0
Auto-slim Stereo	£7 10 0
Auto-Slim Mono Plug-in head	£7 7 0
Auto-Slim De Luxe Mono AT6	£11 9 0
Auto-Slim De Luxe Stereo AT6	£12 5 0
AT5P, Mono	£10 8 2
AT5P, Stereo	£11 5 11
3000LM with stereo cartridge	£11 11 11

Postage on all above 5/-.

COLLARO Studio C60. Wired for stereo with monaural cartridge. **£6 19 6**

MAGNAVOX-COLLARO latest model. 4-speed Stereo Autochanger. Fitted diamond stylus and record dust cleaning attachment Stereo **£7 19 6**

TRANSCRIPTION MOTORS

GARRARD 4HF, ster. or mon.	£16 19 6
GARRARD 401	£32 10 0
GARRARD Lab. 80, Mono	£28 17 8
GARRARD Lab. 80, Stereo	£29 15 5
GARRARD 301 (Strobe)	£21 0 0
GARRARD A with GCS	£19 14 0
GARRARD with EV26A	£20 10 0
PHILIPS AG/1016	£12 12 0
BRAUN PC4L Stereo	£12 9 6
CONNOISSEUR	
Craftsman II	£17 2 11
Craftsman III	£22 19 6
Model B	£25 4 0
LENCO GL58	£17 1 9
LENCO G88	£18 18 5
LENCO GL70	£27 9 4
THORENS 135	£35 8 4
THORENS TD124	£38 7 4

SINGLE PLAYERS

Auto start and stop. With pick-up and crystal cartridge.

GARRARD T.A. Mk. II Mono	£7 17 3
GARRARD SRP10 latest model single player with G.C.S.	£5 9 11
COLLARO JUNIOR 4-speed motor and pick-up	69/6
6 volt battery version, 4-speed with pick-up	69/6

All other current models available. Postage on all above 5/- extra.

EMI 4-SPEED SINGLE RECORD PLAYER

New, unused and individually boxed fitted with light-weight pick-up with ACOS G.P. 73/2 stereo cartridge. Cabinet space required 13½ × 12½ × 4½in. 9in. metal turntable is fitted with Auto-stop. For use on 200/250 volt A.C. Mains. The stereo cartridge will play all types of Mono Records. 78s, L.P.s, etc., but if desired a G.P. 67 LP/78 Mono cartridge will be supplied in lieu of the GP73 at no difference in cost.

LASKY'S PRICE 79/6 Post 3/6.

HI-FI FURNITURE by RECORD HOUSING

The full range of Record Housing equipment—cabinets, speaker enclosures, etc., stocked. Delivered anywhere. Catalogue FREE on request.

TAPE RECORDERS

REFLECTOGRAPH MODEL

SEMI-PROFESSIONAL TAPE RECORDER

These recorders are new and guaranteed in the maker's original cartons. They represent an excellent opportunity for the professional and the quality conscious amateur to acquire the best at almost half price. Brief specifications: Frequency response 35 to 15,000 c/s at 7½ i.p.s.; two speeds—7½ and 3¾ i.p.s.; 3 motors; 8½in. reel capacity; record level meter; separate record and playback volume controls; bass and treble controls; fast forward and rewind; built-in 8 × 6in. speaker with extension L.S. socket; monitoring facilities provided through the internal speaker; outlet from pre-amplifier for extra amplification; for 200/250 v. 50 c.p.s. mains use; tape position indicator fitted; inputs for microphone and radio/pick-up. The recorder is finished in grey and is mounted in free-standing mahogany plinth size: 20 × 16 × 9in.

LASKY'S PRICE 69 Gns. **List price of this Recorder is £110/5/-.** Carriage and Insurance 30/- extra.

FEW ONLY—Carrying Cases for the Reflectograph. **LASKY'S PRICE 6½ Gns.** Post 5/-.

PAMPHONIC VR 53 STUDIO RIBBON MICROPHONE

For use with the Reflectograph Model A Recorder. Low quality Ribbon Microphone. New and unused in maker's original packing. Low impedance. **Listed at £9/19/6.**

LASKY'S PRICE £4.19.6 Post 7/6. Post free if ordered with the Reflectograph Recorder.

HIGH QUALITY TAPE RECORDERS

Complete with crystal microphone, reel of tape and empty spool. General specification: Tone Control; Visual Recording Indicator; Inputs; Microphone; Radio; Record-Player; Telephone Adaptor; Automatic Erase; Fast forward and reverse; 3 ohm speaker with extension socket; **Carrying Case** with detachable lid. Size for Models A and B: 14½ × 14 × 6½in. Size for Models C and D: 14 × 12½ × 6½in.

MODEL A Fitted with Collaro ¼-track Studio Deck. Speeds 1⅞, 3¾ and 7½ i.p.s. Spool capacity 7in. Playing Times: up to 18 hours. Frequency Response: 12,000 c.p.s. at 7½ i.p.s. Mains Voltage 200-250 v. 50 c/s A.C. Output 3 watts.

LASKY'S PRICE 27 Gns. Carriage and Insurance 15/- extra.

MODEL B Fitted with Collaro ¼-track Studio Deck. Specification as for Four Track model above. Maximum Playing Time: up to 9 hours from one reel of tape.

LASKY'S PRICE 25 Gns. Carriage and Insurance 15/- extra.

MODEL C Fitted with B.S.R. ¼-track Deck. Specification: Single speed, 3¾ i.p.s. Freq. response 10,000 c.p.s. at 3¾ i.p.s. Spool capacity: 5¾in. Mains voltage 200-250 v. 50/60 c/s A.C. Output: 3 watts. Playing time up to 3 hours.

LASKY'S PRICE 18 Gns. Carriage and Insurance 15/- extra.

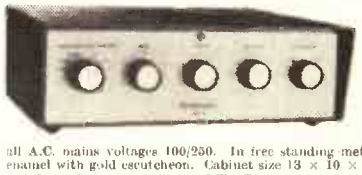
MODEL D Fitted with B.S.R. ¼-track Deck otherwise same specification as the Model C but maximum playing time increased up to 6 hours.

LASKY'S PRICE 21 Gns. Carriage and Insurance 15/- extra.

H.P. Terms are available on the above models.

AMPLIFIERS

PAMPHONIC TYPE 1004 AMPLIFIERS



A 10-watt integrated mono amplifier with inputs for Radio, Tape, Mic. and pick-up. Frequency response 20 c/s to 30 Kc/s. Three different equalising settings for pick-up. Volume, bass and treble controls fitted. Also variable contour (slope) control. Output socket for tape recorder fitted. Extra H.T. and L.T. provided for auxiliary equipment. Output impedance 3 and 15 ohms. For all A.C. mains voltages 100/250. In free standing metal cabinet, finished in brown hammer enamel with gold escutcheon. Cabinet size 13 × 10 × 4in. **List Price 25 Gns.**

LASKY'S PRICE 15 Gns. Carriage and Packing 10/6.

ARMSTRONG EQUIPMENT

We stock all the latest models by this famous manufacturer.

A.F.208	£21 4 0	T.4.c	£17 19 0
Model 227M	£36 15 0	T.4.b.	£20 8 0
Model 223	£28 15 0	127M	£26 10 0
Stereo 55	£29 18 0	127	£37 10 0
Model 227	£52 15 0	S.T.3. Mk. II	£25 12 0
Model 226	£61 0 0	A.26 Stereo Amp.	£23 12 6
Model 222 Amp.	£27 10 0	P.C.U. 25 Stereo Pre-amp.	£21 0 0
Model 224	£22 10 0	Optional cases	£3 10 0

H.P. Terms available.

"VIKING" GUITAR/P.A. AMPLIFIERS

"TRANSISTOR 50"—50 watts, fully transistorised with tremolo	**45 Gns.**
"SOUND 30"—30 watt valve model, 8 inputs	**35 Gns.**
Matching Speaker System for the "Viking" amplifiers	**33 Gns.**

For details and illustration see March "W.W." including special package deal offer for the amplifiers and speaker system.

LASKY'S RADIO FOR FINEST VALUE and COURTEOUS SERVICE

4WW—144 FOR FURTHER DETAILS.

ervice in Great Britain

CONSTRUCTORS BARGAINS

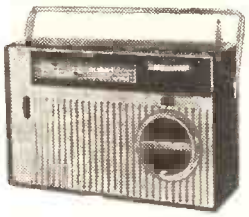
LASKY'S RADIO

THE WIDEST RANGE AVAILABLE TODAY FOR HOME CONSTRUCTION OR READY BUILT TO HIGHEST STANDARDS

We consider our Construction Parcels to be the finest value available on the home construction market. If on receipt you feel not competent to build the set, you may return it as received within 7 days, when the sum paid will be refunded less postage.

TRANSISTOR PORTABLES

THE SKYROVER AND SKYROVER DE LUXE



GENERAL SPECIFICATION
7 transistor plus 2 diode superhet; 6 waveband portable receiver.
The SKYROVER and SKYROVER DE LUXE cover the full Medium Waveband and Short Waveband 31-49M., and also 4 separate switched band-spread ranges, 13M., 16M., 19M., and 25M., with Band Spread Tuning for accurate Station Selection. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions. Superhet, 470 Kc/s. All Mullard Transistors and Diode. Uses 4 U2 batteries. 5in. Ceramic Magnet P.M. Speaker. Easy to read Dial Scale. 500 MW Output. Telescopic Aerial and Ferrite Rod Aerial.

NEW! SKYROVER MK. III (Illustrated). Now supplied with redesigned plastic cabinet, finished in black and grey with chrome trim, edgewise controls. Controls: Waveband Selector, Volume Control with on/off switch, Tuning Control. In plastic cabinet, size 10 × 6½ × 3½in. with metal trim and carrying handle.

Can now be built for	Post	H.P. Terms:	Total H.P.P.
£8.19.6	5/- extra.	£1 deposit and 11 monthly payments of 16/6	£10/1/6

The SKYROVER De Luxe Tone Circuit is incorporated, with separate Tone Control in addition to Volume Control. Tuning Control and Waveband Selector. In a wood cabinet, size 11½ × 6½ × 3in. covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

Can now be built for	Post	H.P. Terms:	Total H.P.P.
£10.19.6	5/- extra.	£1 deposit and 11 monthly payments of 20/-.	£12/5/-

Data for each receiver: 2/6 extra. Refunded if you purchase the parcel. Four U2 batteries 3/4 extra. All components available separately.

★ **LONG WAVE AND COVERAGE IS NOW AVAILABLE FOR THE SKYROVER & SKYROVER DE LUXE** A simple additional circuit provides coverage of the 1100/1950 M. band (including 1500 M. Light programme). This is in addition to all existing Medium and Short wavebands. All necessary components with construction data. Only **10/-** extra. Post Free.

This conversion is suitable for Skyrover and Skyrover De Luxe receivers already constructed.

REALISTIC SEVEN

Fully tunable over long and medium wavebands. Uses 7 Mullard Transistors; plus Diode OA70.

STAR features:
★ 7 Transistor Superhet. ★ 350 Milliwatt output 4in. high flux speaker. ★ All components mounted on a single printed circuit board, size 5½in. × 5½in., in one complete assembly. ★ Plastic cabinet, with carrying handle, size 7in. × 10in. × 3½in. in blue grey. ★ Easy to read dial. ★ External socket for car aerial. ★ I.F.-frequency 470 Kc/s. ★ Ferrite rod internal aerial. ★ Operates from PP9 or similar battery. ★ Full comprehensive data supplied with each receiver. ★ All coils and I.F.s, etc., fully wound ready for immediate assembly. An outstanding Receiver.

Can be built for **£5 . 19 . 6** Post 4/6.

REALISTIC SEVEN De Luxe By popular request a De Luxe version of the well-known Realistic Seven now available. With the same electrical specification as standard model—PLUS A SUPERIOR WOOD CABINET IN CONTEMPORARY STYLING covered in attractive washable material, with super-chrome trim and carrying handle. Also a full vision circular dial, externally mounted to further enhance the pleasant styling. **ONLY £1 EXTRA.**
Both models: Battery 3/9 extra. (All components available separately). Data and instruction separately 2/6, refunded if you purchase parcel.

SINCLAIR SUPER MINIATURES

THE MICRO-6 Self-contained pocket radio, size only 1⅞in. × 1 5/16in. × ⅝in. Truly amazing performance. All parts complete with earphone and detailed construction data. Mercury cell 1/11 extra (2 required). CAN BE BUILT FOR **59/6**

THE SLIMLINE The new 2-transistor pocket radio size only 2¾in. × 1⅝in. × 1⅜in. Micro alloy transistorised and printed circuit. All components available separately. Easy to assemble. CAN BE BUILT FOR **49/6**

THE NEW X10 10 watt power amplifier fitted with integrated pre-amplifier. Requires only 1 mV. for an output of 10 watts undistorted. Size only 6 × 3 × ⅞in. Weight 5 oz. Circuit uses 7 M.A.T.s and 4 RF power transistors. KIT PRICE **£5.19.6**

AVAILABLE READY BUILT, TESTED AND GUARANTEED, £6/19/6 POST FREE.
3 pots. for vol., Bass and Treble, 7/6 the 3 extra. Mains power pack, if required, 54/-.

MINIATURE EARPIECES

for Transistor Radios, Transparent ear inserts with 3ft. cord, sub-min. jack and socket. Fully guaranteed. Post free.

CE.5.	Crystal high imp.	5 0
MR.4.	Magnetic low imp.	6 6

CONSTRUCTORS BARGAINS

THE NEW "KUBA" IMPORTED AM/FM STEREO RADIOGRAM CHASSIS

Long, medium and short waveband coverage, plus V.H.F./F.M. Piano key wavechange. Separate fly-wheel tuning on A.M. and F.M. Bass, treble and balance controls. Magic-eye tuning indicator. Ferrite rod aerial. The very latest printed circuitry. Provision for multiflex. 5 valves: line-up: ECC85, ECC801, ECC83, ELL80, EAF801. Full vision tuning scale size 21 × 8in. Overall dimensions 21 × 6½ × 8in. Made to the very highest standards. 3Ω output. 5 watts per channel.

LASKY'S PRICE 29½ GNS. Carriage and insurance 12/6 extra.

BUILD A HIGH QUALITY TAPE RECORDER

Using the famous Collaro "STUDIO" deck and MARTIN pre-assembled amplifiers, 2- or 4-track models.

COLLARO STUDIO TAPE DECK.
Latest model 3 speed, 3 motors. Takes 7in. reels. Fitted with half-track heads. New and Unused. LASKY'S PRICE £10/10/-. Carr. & Pack. 7/6.

COLLARO STUDIO TAPE DECK. As above but fitted with the latest quarter-track heads. LASKY'S PRICE £13/19/6. Carr. & Pack. 7/6.

MARTIN TAPE RECORDER AMPS. Designed for use with Collaro Studio Tape Deck. In sub-assemblies for immediate installation. 6-valve circuit. Comprehensive instructions make final assembly as simple as possible. Everything supplied including valves, etc. Monitoring facilities. 3 ohm output, speed equalising, etc. For 200-250 v. A.C. mains. PRICES: ¼ track Model £11/11/-, ½-track Model £12/12/-. Post 2/6.
Portable carrying case designed to take the Collaro Studio Tape Deck and the Martin Tape Amplifier. Fitted with 9 × 5in. speaker. Price complete with speaker £5/5/-. Post 5/-.

HI-FI TAPE RECORDER HEADS

High Imp. Record/Play. Low imp. erase.
Upper or lower track. LASKY'S PRICE 29/6. Post free per pair. State track required.

MARRIOTT "X" Type ¼-track heads	LASKY'S PRICE	4 GNS. pair.
½-track heads Record/Play and Erase	LASKY'S PRICE	59/6 pair.
MICHIGAN ¼-track heads	LASKY'S PRICE	5 GNS. pair.
BOGEN ¼-track heads	LASKY'S PRICE	7 GNS. pair.

TRANSISTORS

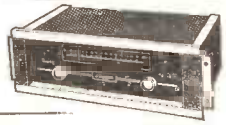
ALL BRAND NEW AND GUARANTEED
GET 81, GET 85, GET 86 2/6; 837A, 874P 3/6; OC45, OC71, OC81D 4/6; OC14, OC70, O76, OC81 (match pair 10/6) 5/6; AF117, OC75, OC200 6/6; OC42, OC43, OC73, OC82D 7/6; OC201, OC204 15/-; OC205, OC206 19/6; OC28 24/6.

TRANSFILTERS

By BRUSH CRYSTAL CO. Available from stock.

TO—01B 465 kc/s. ± 2 kc/s.	TO—02D 470 kc/s. ± 1 kc/s.		6/6 EACH
TO—01D 470 kc/s. ± 2 kc/s.	TF—01B 465 kc/s. ± 2 kc/s.		
TO—02B 465 kc/s. ± 1 kc/s.	TF—01D 470 kc/s. ± 2 kc/s.		Post 6d.

JASON EQUIPMENT



High quality home construction units for the discerning Hi-Fi enthusiast. We stock the complete range of component parts.

FROM PRE-AMP TO 20 WATT HI-FI STEREO ASSEMBLY

BY BUILDING WITH MARTIN AUDIOKITS—AVAILABLE FROM STOCK.
Using specially developed circuits, the very latest transistors and printed circuits—these kits are all fully checked and tested before leaving the factory.

KIT 1.	5-stage Matching Input Selector Unit	LASKY'S PRICE £2/7/6
KIT 2.	Pre-amplifier with volume control	LASKY'S PRICE £1/17/6
KIT 3.	3-Channel Mixer, with plug-in adaptors for individually matching each circuit. Adaptors 8/6 each	LASKY'S PRICE £3/19/6
KIT 4.	Pre-amplifier with tone/volume control stages	LASKY'S PRICE £3/2/6
KIT 5.	10 and 3 watt Main Amplifier	LASKY'S PRICE £5/12/6
KIT 6.	Power supply Converter Unit	LASKY'S PRICE £2/12/6
KIT 7.	15 ohm version of Kit 5	LASKY'S PRICE £6/12/6
KIT 8.	Power supply for Kit 7	LASKY'S PRICE £2/15/-

TAPE DECK MOTORS Motors for the Collaro Studio Deck—new and unused. 200-250 v. A.C. Take-up and rewind. Listed at £2/5/- each.
LASKY'S PRICE 14/11 each Post 2/6.
State motor required when ordering.

High quality tape deck capstan motor made by E.M.I. Holland. Bi-directional. Size 4in. dia. × 2in. high, 1in. × ¼in. spindle. **LASKY'S PRICE 19/11** Post 3/6

SEND FOR OUR LATEST BARGAIN BULLETIN. 20 foolscap pages. Hundreds of Bargains for the "ham" and service man. PRICE 6d. POST FREE.

LASKY'S FOR SPEEDY MAIL ORDER SERVICE

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LASKY'S RADIO

Britain's Leading Suppliers of AUDIO & TEST EQUIPMENT

HUGE STOCKS OF COMPONENTS, TEST GEAR, READY BUILT BARGAINS, ETC. SPEEDY MAIL ORDER SERVICE

READY BUILT BARGAINS

THE "TRANSISTOGRAM"

A portable battery operated fully transistorised Record Player—Made by famous British manufacturer, fully guaranteed. Size 6½ × 12 × 10½in. Weight 10 lb. Operates on 6 U2 batts. 4 speeds—16⅔, 33⅓, 45 and 78 r.p.m. Goldring Cygnet player unit with lightweight pick-up fitted with CM-60 turn over ceramic cartridge. Output 500 mW into 5in. ceramic magnet speaker fitted into lid for maximum sound distribution. Cabinet constructed of wood, covered in two tone (pale blue/grey) leather cloth. High quality amplifier with tone and vol. controls gives excellent reproduction. Plays 7in., 10in. and 12in. records. Today's value 12 gns.

LASKY'S PRICE £6.19.6 New and guaranteed. Carr. & Ins. 7/6. 6 U2 batts. 4/- extra. (Leakproof 5/-)

TRANSISTOR POCKET RADIOS

Ideal Gifts—all supplied complete with personal earpiece, battery and carrying case. Fully guaranteed—ready to use. **POST FREE.**

BOY'S 2 TRANSISTOR In attractive plastic case. Size only 4in. × 2¾in. × 1in. Fitted 2½in. speaker. Socket for personal earpiece. Uses PP3 battery. Tunabel over full medium waveband. **LASKY'S PRICE 39/6**

BOY'S 4 TRANSISTOR MODEL LASKY'S PRICE 49/6

6 TRANSISTOR MODEL

Fully built in plastic case. 4in. × 2½in. × 1in. with 2¾in. speaker. Uses single PP3 type battery Tunable over full medium waveband. **LASKY'S PRICE 69/6**

2 Waveband (Long and Medium) Model Size 5 × 3½ × 1½in. Cream/black plastic case. Real leather carrying case. **LASKY'S PRICE £5.9.6**

STAAR KINDER RECORD PLAYER

45 r.p.m. 6 v. Batt. operated. Complete with pick-up fitted crystal cartridge. Size only 7½ × 6in. Fitted auto. stop and start. New and perfect. **LASKY'S PRICE 49/6** Post 2/6.

NOW IN STOCK—2 speed model for 33⅓ and 45 r.p.m. (*As illustrated*) **59/6** Post 2/6.

THE HARROW POWER PACK

Battery eliminator for portable radios, etc. Converts your battery radio to A.C. mains. Replaces 4½ v., 6 v. and 9 v. batts. Size only 3in. × 2in. × 2½in. State Voltage required when ordering. **LASKY'S PRICE 29/6** Post 2/-

GUITAR PICK-UPS

CGM5 Crystal—high imp. Size only 1½in. × ⅝in. × ⅜in. Clips to finger board—no screws. Complete with cable. **LASKY'S PRICE 15/11.** P. & P. 1/-.

CGM35. Magnetic—high imp. Fully adjustable pick-up position carrier. Simply fixed. Separate tone and volume control. Heavy chrome finish. Pick-up size 3⅜in. × 1½in., control size 2½in. × 1¾in., complete with long lead and screened jack plug. **LASKY'S PRICE 59/6.** Post 1/6.

COMMUNICATION RECEIVERS

MODEL HE30

Covers 540 Kc/s. to 30 Mc/s. Facilities: A.N.L., A.V.C. and M.V.C. Q Multiplier also serves as B.F.O. H.F. stage and two I.F. stages ensure high sensitivity and selectivity. 9 valves. Stand-by position for use with a transmitter, 8 meter fitted. 200-250 v. A.C. mains. Brand new with full instruction manual, steel cabinet, size 15 × 8 × 10in.

LASKY'S PRICE 33 GNS. | **KIT PRICE 25 GNS.** | **POST FREE**

H.P. Terms (Ready Built): £6/13/- dep. and 11 months at £2/16/-. Total H.P.P. £37/9/-

MODEL HE40

Covers medium wave band and 1.6-4.4 Mc/s., 4.5-11.0 Mc/s. 11.0-30.0 Mc/s. in separate switched band spread ranges. Controls B.F.O. Sensitivity, A.N.L. Receiver—Stand-by Switch. Tone Switch, S-Meter. For 200/250 v. A.C. Internal loop and telescopic antennae fitted. 4 valves and metal rectifier. Size 13½ × 8½ × 5½in. Full instruction manual. No Kits available.

LASKY'S PRICE 19 GNS. H.P. Terms £4 dep. and 11 months at £1/12/-. Total H.P.P. £21/12/-. Carr. & Pack. 10/-

MODEL HE80

14-valves. Freq. range 540 Kc/s.—30 Mc/s. and 144-146 Mc/s. Dual conversion on 2 metres, with extra R.F. stage. Single R.F. stage, two I.F. stages on all other bands. B.F.O. and Q-multiplier circuits. Improved A.N.L. and voltage regulated powerpack. "S" meter, band spread on amateur bands. Outputs for speaker and phones. Steel case 17 × 7½ × 10in. For 200/250 v. A.C. mains. Brand new with full instruction manual. No kits available.

LASKY'S PRICE 59 GNS. H.P. Terms £12/19/- dep. and 11 mths. at £4/18/-. Total H.P.P. £66/17/-. Carr. & Pack. FREE

TEST EQUIPMENT

TEST METER ADAPTOR

Type PE 220—this is a fully transistorised device which enables any 50 microamp D.C. Multimeter to be used in place of a valve volt meter. On the 1 v. range an impedance of 1 megohm is offered which increases on the 1,000 v. range to 100 megohms. 7 ranges: 1 to 1,000 v. Designed for immediate connection to Avo 7, 8 and similar size meters but quite suitable for use with any other 50 microamp meter. Size 6 × 6 × 5in. New and boxed. **List Price 7 Gns.**

LASKY'S PRICE 39/6. P. & P. 2/6. Set of batteries 7/5 extra.

TEST METERS

brand new complete with test leads and batts.

HAIKI 20,000 O.P.V.	£5 19 6	P-1 2,000 O.P.V.	£2 19 6
TE-13 1,000 O.P.V.	£1 19 6	P-3 4,000 O.P.V.	£4 2 6
TMK-500 30,000 O.P.V.	£8 17 6	MT-559 50,000 O.P.V.	£10 19 6
200-H 20,000 O.P.V.	£5 5 0		

Complete range of Avo and Taylor Meters and Test Equipment in Stock, also complete range of all Nombrex and Jason Test Equipment.

INTERNATIONAL TAPE

Famous American Brand Fully Guaranteed at record low prices. In sealed cartons.

3in.	Message tape, 150ft.	3/6
3in.	Message tape, 225ft.	4/11
3in.	Message tape, 300ft.	7/6
3¼in.	Triple play, 600ft. Mylar base	15/-
4in.	Triple play, 900ft. Mylar base	17/6
5in.	Double play, 1,200ft. Mylar base	15/-
5in.	Long play, 900ft. Acetate base	10/-
5in.	Standard play, 600ft. P.V.C. base	8/6
5in.	Triple play, 1,800ft. Mylar base	35/-
5¾in.	Double play, 1,800ft. Mylar base	22/6
5¾in.	Long play, 1,200ft. Acetate base	12/6
5¾in.	Standard play, 850ft. P.V.C. base	11/6
5¾in.	Triple play, 2,400ft. Mylar base	45/-
7in.	Standard play, 1,200ft. Mylar base	12/6
7in.	Long play, 1,800ft. Mylar base	19/6
7in.	Double play, 2,400ft. Mylar base	25/-
7in.	Long play, 1,800ft. Acetate base	15/-
7in.	Triple play, 3,600ft. Mylar base	58/6

Post 1/- extra per reel; 4 reels and over Post Free.

TELEPHONE AMPLIFIER

Powerfully amplifies the incoming call. Fully transistorised. Pick-up suction fixed to phone. Battery-operated. Fitted with on/off switch and vol. control. Size 4½ × 3 × 1½in. Complete with PP3 battery. **LASKY'S PRICE 69/6** Post 2/6.

BABY ALARM/INTERCOM

Fully transistorised miniature intercom that has all the features of sets many times its size. Battery consumption is exceptionally low and makes this system particularly suitable for use as a Baby Alarm. Specification: 2 transistor: Sensitivity; more than 55 dB. Power: one 9 v. batt. or equiv. (approx. life 50 hours). Size of units 4 × 2½ × 1½in. The sturdy plastic cabinets are finished in ivory and silver with chrome stands. **LASKY'S PRICE 59/6.** P.&P. 2/6.

EXPORT MODEL—TV OFFER

625 line T.V. chassis (Export Model). For 200-250 v. A.C./D.C. mains. Fitted with Band I-III turret tuner. Fully loaded with 12 sets of coils for all CCIR channels in these band F/M sound. Made by famous British manufacturer. 15 Mullard valves. Electrostatic focus and deflection. Will take 17in., 19in. 21in. or 23in. CRT. All controls fitted. Supplied new and unused with all valves. 7in. × 4in. speaker and 17in. CRT (less cabinet).

LASKY'S PRICE £25 Carr. & packing FREE to any part of the World. (Tube sent at buyer's risk.) An allowance of £3 will be made if the CRT is not required. Circuit data included FREE.

CRYSTAL PICK-UP CARTRIDGES

LOWEST PRICES EVER!

All Complete with Styli: L.P. and Standard, fully guaranteed. Standard Fitting will fit most P.U. Arms and Heads. Postage 1/- extra each.

Acos G.P. 5/9	14/-
Acos G.P.65/3	15/-
Acos G.P.65/1	17/-
Acos G.P.67/1	14/-
STEREO Acostereo 73/1, with 2 sapphires	25/-
Acostereo 73/2, with diamond LP/Stereo and sapphire Std.	29/6
Ronette Stereo O.V. Turnover with 2 sapphires	25/-
Ronette Stereo type 105 and 106 with 2 sapphires	25/-
Ronette Stereo type 105 and 106 with diamond LP/Stereo and sapphire Std.	35/-

AND EVEN LOWER PRICES

Save money! Some of these cartridges are cheaper than styli

C.T.I Mono, 2 sapphires	4/11
Collaro Type C, 2 sapphires, stereo	15/-
Collel SCI Diamond LP, stereo	17/6
Sonotone 8T, stereo	19/10
Sonotone 2TA, mono	15/-

Postage 1/- extra each.

TAPE POSITION INDICATOR

Open type—as used by most makers. With re-set knob. **3 DIGIT 7/6. 4 DIGIT 10/6.** Post 9d. on each.

ELECTRONICS (FLEET ST.) LTD.

207 EDGWARE ROAD, W.2. Few yards from Praed Street. PADdington 3271/2 Open all day Saturday. Close 1 p.m. Thursday.

152/3 FLEET STREET, E.C.4. Near "Daily Express" Building. FLEet St. 2833. Open all day Thursday. Close 1 p.m. Saturday.

33 TOTTENHAM COURT ROAD, W.1. 2 mins. Oxford Street. Nearest Station, Goodge Street. MUSeum 2605 Open all day Saturday. Close 1 p.m. Thursday.

PLEASE ADDRESS ALL MAIL ORDERS TO OUR HEAD OFFICE:—207 EDGWARE ROAD, W.2.

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LASKY'S FOR D.I.Y. CONSTRUCTION BARGAINS

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TEST EQUIPMENT

★ Marconi Universal Impedance Bridge Type 373d. Perfect condition ..... £30. P.P. 15/-
★ Marconi Circuit Magnification Meter Type 329G. As new. Late model ..... £65. P.P. 30/-
★ Marconi Signal Generator Type 144G. Perfect. £18. P.P. 25/-
★ Muirhead Valve Maintained Tuning Fork Type D-630-C incorporates stabilised power unit. Frequency 1,000 c.s. These instruments are new and comply to laboratory standards ..... £25.
Furzhill B.F.O. 0-10 kc/s. Perfect condition. As new. Complete with transit case, etc. £12. P.P. 20/-

OSCILLOSCOPES

Cossor Double Beam Type 1035, perfect condition. £27/10/-. P.P. 20/-.
Cossor Double Beam Type 1052, portable, condition new, £30. P.P. 20/-.
Hartley/Erscine Double Beam Type 13a, perfect condition. £25. P.P. 20/-.
B.P.L. ELECTRONIC FREQUENCY METER TYPE FM406-B. Mk. 2. Range 100 c.s.-10 kc/s. direct reading on 6in. scale meter, facilitates for output to precision recorder if required, as new, £35. P.P. 17/6.

G.E.C. V.H.F. PANORAMIC RECEIVER TYPE B.R.T.652. Range 70-200 Mc/s. A laboratory instrument in as new condition. £125.

★ GR. type 583A Power Output Meters, range 5m W. to 5 w., input impedance 2.5-20k ohms, meter calibration 0-50mW and 0-17 DB, multiplier .1, 1, 10, 100 size 10 × 6 × 3in in perfect condition £12/10/-. P.P. 7/6.
Measurement Corporation Square Wave Generator type 71 Frequency range 5 c.p.s. to 100 Kc/s. for 250 v. A.C. operation, size 15 × 8 × 7in., in as new condition ..... £35. P.P. 17/6

PREC. DIRECT READING CAPACITY METER

Range 0-250 pf in three switched ranges, capacitators can be measured on this exceedingly accurate meter directly to terminals or by probe, easy to set up, easy to use, indication to 4inch meter, size 12 × 8 × 8in. ..... £35. P.P. 15/-.

COMMUNICATIONS RECEIVERS

★ AR88D, as new ..... £45. P.P. 25/-
★ Hallicrafters 827 FM/AM 27.8 to 143 Mc/s. from £25. P.P. 25/-
★ S.T.C. B46 1.5 to 15 Mc/s. perfect order .. £12. P.P. 17/6
★ Hammerlund Super Pro SP4008X, 1.25 to 40 Mc/s. with power unit, in excellent condition ..... £45. P.P. 17/6
★ Marconi CR 100/2 60 Kc/s. to 30 Mc/s. perfect condition £25 P.P. 19/6.

All receivers and test equipment offered are in excellent operating condition unless otherwise stated.

RELAYS TYPE 3000

8 C.O. double wound coil 10+55 ohms, special latching type, a reverse polarity current to either coil releases armature, operating voltage, 6 or 12 v. d.c., brand new stock by famous manufacturer ..... 17/6 ea.
6 C.O. 500 ohms, new stock ..... 10/- ea.
6 C.O. 300 ohms, new stock ..... 10/- ea.
6 C.O. 350 ohms, new stock ..... 10/- ea.

RELAYS TYPE 600

4 C.O. 1,000 ohms, new stock ..... 7/- ea.
4 C.O. 500 ohms, new stock ..... 7/- ea.
4 C.O. 500 ohms slugged type ..... 7/6 ea.

RELAYS, MINIATURE

S.T.C. 4184GD, 24 v. 700 ohms, 2 C.O.
S.T.C. 418gb, 6 v. 45 ohms, 2 C.O.
S.T.C. 4184GE 48 v. 2,700 ohms 2 C.O.
S.T.C. 4186EA, 1 v. 2 ohms, 2 C.O.
All above relays 8/6 each, plus P.P on all relays 1/-.

SIGNAL GENERATORS VHF/UHF

G.R. type 804 Signal Generators. Frequency range 8-330 Mc/s directly calibrated in 5 switched bands, mod. up to 75% at 400 c.p.s., output from 1uv. to 20mv., easy read output and mod. per cent meters, for 250 v. A.C. operation size 19 × 12 × 8in. this fine laboratory instrument at a price you can afford, in perfect condition, £25 packing and carriage paid.

POWER UNIT TYPE 234A

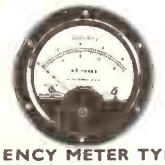
A source of power to operate your 1392 R/X or any equipment that requires a fully smoothed output of 250 v.d.c. + 6.3 v. at 6 amps., for bench or 19in. rack mounting, fully fused tapped input 200 to 250 v. a.c., brand new cased units at only 55/-. P.P. 12/6.

DOUGLAS COIL WINDER

Hand operated type in perfect condition, complete with counter wire, guides, etc. ..... £35. P.P. 20/-

SPECIAL OFFER

of new boxed Weston dual range Micro Amp Meters 50 and 100 size 3½in.,



flush mounting, sealed type

59/6

P.P. 3/6.

FREQUENCY METER TYPE CT49

Small radio absorption meter frequency range 450 c/s to 22 Kc/s in four directly calibrated ranges ideal for frequency check of terminal units, F.S.K. etc. power supplies dry batteries 1.5v and 22v. Price as new £8.10.0. P.P. 12/6.

HEADSETS AND MIKES

DLR5 sound powered ..... 10/6 P.P. 1/6
No. 4A Hand Mikes ..... 7/6. P.P. 1/6
★ **RADAR RANGE CALIBRATOR TYPE 4807** (10s/16906) ★ Complete with all accessories as new.
Wave guide 3 cm. in 5ft. lengths, U.S.A. manufacture, new wrapped, £2/10/- per length.

P. F. RALFE
423 GREEN LANES, HARRINGAY, LONDON, N.4.
MOUNTVIEW 6939

VIBRATION ABSORBERS

for motors, fans, blowers up to 1 h.p. and equipment, as illustrated 2in. O.D. ⅜in. screwed, each end. Will make ideal whip aerial bases. New in maker's cartons, 12/6 per carton of four. P.P. 2/6.

UNIVERSAL WAVEMETER R502

Absorption type wavemeter by S.T.C. frequency range 100 kc/s to 48 Mc/s with nine plug-in coils. Powered by 1½ volt dry cell and triode valve, complete with all calibration charts 250 micro amp meter, super slow motion dial, etc., the wavemeter coils calibration charts are contained in a neat wooden transit case, 14 × 13 × 8in., excellent condition, £4/19/6, carr. 7/6.

TEN TURN COLVERN HELIPOTS

30K ohms. brand new stocks ..... 19/6. P.P. 1/3.

MARCONI SIGNAL GENERATOR TYPE 726/C1

Frequency range 200 to 400 Mc/s directly calibrated. A modern laboratory instrument, in as new condition £55. P.P. 25/-

MINIATURE RELAY BANKS

Six miniature relays 9-12 v., 1 make per relay, contained in neat aluminium case 6 × 4 × 1½in., with six half inch spaced crystal holders, designed to switch any desired crystal by remote control. Relays and crystal holders can be easily removed for other uses if required, terrific value, only 15/6. P.P. 1/6.

SOLARTRON OSCILLOSCOPES

Type C.D. 1014 Double Beam portable, late model price £55.

L.T. TRANSFORMER

5 v. C.T. three times, at 5 amps., 230 v. primary. These U.S.A. transformers are excellent for charging purposes. New boxed, 22/6. Carr. 3/6

Western Electric Sound Level Meter type RA331 to measure from .5db to 120db for 250 v. A.C. operation. £25. P.P. 15/-
Genera Radio Portable Sound Level Meter. Battery operated. Range 40-120dB as new condition. £25. P.P. 12/6
Furzhill Micro Watt output meters, type 140 input impedance 150 ohms, range 1 to 20,000 micro watts. £5/10/- P.P. 5/6
Marconi Conductance Meter, type TF72lb battery operated.
Hewlett Packard Audio Oscillator type 205/Ag perfect condition ..... £30. P.P. 30/-

We have in stock a fair range of teleprinting equipment, including Audio and I.F. F.S.K. units. Your enquiries are invited.

LASKY'S RADIO

Super Spring Bargain for Motorists

CAR RADIO SCOOP!

BY FAMOUS BRITISH MANUFACTURER—

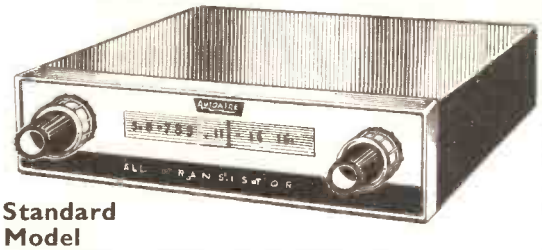
READY TO FIT

Standard Model

A high quality all transistor car radio covering the full Medium waveband. For use on all 12 v. D.C. systems—positive or negative earth. Very attractively styled in silver and black to harmonise with all interior styles. Standard dimension steel case 7 x 7 x 2in. complete with metal fixing brackets. Illuminated dial, "easy hold" control knobs. Tunable over full medium waveband—200/550 metres. Leads are fitted for battery, aerial and loudspeaker connections, a fuse is incorporated in the battery lead.

Technical details:
12 v. D.C., positive or negative earth; tuned R.F. stage superhet; fully transistorised using 7 semi conductors; power transistor with 3 ohm output sufficient for the largest car; permeability tuning for positive selection and stability.

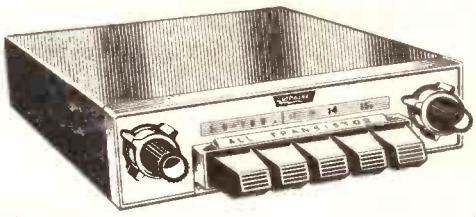
Instruction book and service manual including circuit diagram supplied. New and unused in makers original cartons. Fully guaranteed. **Today's value almost double.**



Standard Model

LASKY'S PRICE £6.19.6 Post 5/6

Excluding speaker and aerial — see list below.



De Luxe Model

Incorporating push-pull output providing 6 watts output together with fully variable tone control and five push button station preselectors. Ready to fit. Size—finish, etc., as standard model. Brand new and unused in makers original cartons. Fully guaranteed.

De Luxe Model

LASKY'S PRICE £8.19.6 Post 5/6

Excluding speaker and aerial — see list below.

A SELECTION OF SUITABLE AERIALS & SPEAKERS

LOUDSPEAKERS.
5in. round 10/6. 7 x 4in. elliptical 11/6. 8 x 5in. elliptical 12/6. Post 1/6.

SPEAKER ESCUTCHEONS.
Chrome plated with matching grille, complete with fixing bolts. New and boxed. 5" round 12/6. 7" × 4" elliptical 15/6.

AERIALS. All heavily chrome plated, complete with connecting lead and plug. **Fully retractable.** Type A28 open 41in., closed 9in. 50/-. Type A24 open 61in., closed 16in. 55/-. Type A20 open 41in., closed 9in. (with locking device) 52/6. **Wing Mounting.** Type A13 opens to 48in. 25/-. Type A40 opens to 62in. 46/-. Post 2/-.

FOR ADDRESSES SEE PRECEDING PAGE

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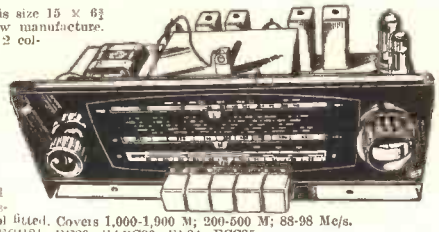
BRAND NEW AM/FM (V.H.F.) RADIOGRAM CHASSIS AT £13.13.0 (CARRIAGE PAID)



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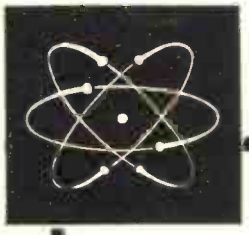

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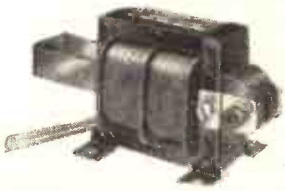

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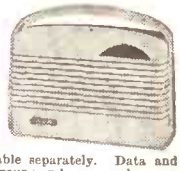

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Portable Power Unit fitted with 1.5 amps. Variable Transformer, switched and fused, with A.C. Voltmeter and panel indicator lamp. **£7/15/-**, p.p. 5/6.

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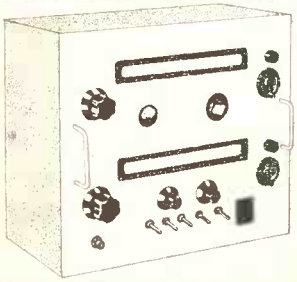
Output: 240 v. ±1.5%.
Max. Current 1 A.
£11/11/-, p.p. 12/6.

VHF HETERODYNE PRECISION FREQUENCY METER TYPE 183



Total Frequency Coverage 20-1,000 Mc/s.

The instrument consists of: Crystal Controlled Oscillator (Crystal 100 kc/s. ±5 c/s.) providing spot frequencies at 25, 50 and 100 kc/s. intervals; Fine (L.F.) Oscillator continuously tuned from 5.0 to 6.25 Mc/s. in 9 bands; Coarse (H.F.) Oscillator continuously tuned from 20 to 300 Mc/s.; and associated mixer and A.F. stages. By using coarse oscillator alone quick frequency identification can be made from 20 to 1,000 Mc/s. with an accuracy of .3%. By using correct measuring procedure, i.e., by calibrating fine oscillator against crystal and beating input frequency with the former an accuracy of ±.02% is easily obtained. Long scales graduated in Mc/s. provide exceptional degree of discrimination. Beat detection by Magic Eye or headphones. Dimensions: 22in. × 19½in. × 14in. Weight 71 lb. Power requirements 115/230 v. A.C.

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30,000 Ω per v. MULTIMETERS

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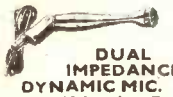
A.C. volts: 0-2.5-10-25-100-250-500-1,000.
D.C. Volts: 0-.5-1-2.5-10-25-100-250-500-1,000.
D.C. Current: 0-50μA.-5-50-500mA.-12 amp.
Resistance: 0-60K-6M-60M.
What more can you ask for than all these ranges plus a specially damped "off" position for transit protection. Brand new, fully guaranteed, complete with leads, batteries and instruction booklet. Inc. P.P. **£7-19-6**

DON'T FORGET THAT ELECTROSURE BRAND RECORDING TAPE AS RECENTLY REPORTED ON IS AVAILABLE ONLY DIRECT FROM US.



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All tapes are 100% tested, have fitted leaders, are boxed and fully guaranteed.
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These tapes are comparable with any other on the British market.

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Postage and packing 1/- per spool 4 or more post free.

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NEW DINSDALE AMPLIFIER

PRINTED CIRCUITS
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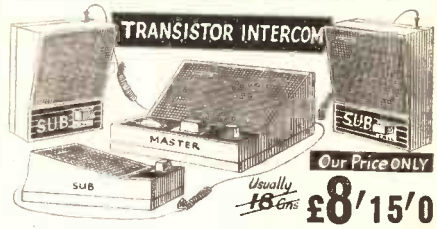
UNDRILLED **30/-** set of 4.

W.W. XTAL. F.M.
UNDRILLED **10/6** set of 2.

NEVIN ELECTRIC LTD.
Arkwright Road, Colnbrook, Bucks.



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Solve your communication problems with this 4-STATION INTERCOM (One MASTER and Three SUBS) housed in attractive plastic cabinets for desk or wall mounting. Four-way press button calling (buzzing) and talking from SUB units to MASTER and MASTER to SUB units. Buzzing system operates to call attention even when switched off, thus saves battery. Operates on single 9 volts PP3 battery which lasts months. Volume control. 2½ in. dynamic speaker. Ideal for Office, Warehouse, Works and Home. Complete with 3 pcs. of cord (each 66 ft.), 45 staples, 1 role of tape and a battery. Ready to operate. P. & P. 4/6.

Two-way TRANSISTOR INTERCOM, Master and Sub two units in Ivory plastic cabinets with chrom. stands. Both units operate on a single battery. Also useful as a BABY ALARM. Indispensable in home, office, shop and warehouse. Size: 4 x 2½ x 1¼ in. Complete with 60 ft. wire and battery. Ready to operate. P. & P. 2/6.

*By using this combined CHARGER & A.C. ELIMINATOR you can use your TRANSISTOR RADIO or INTERCOM on domestic A.C. mains. **Most effectively charges Dry Batteries 006P or PP3 used in TRANSISTOR RADIOS and INTERCOMS. Unbeatable value, save your pounds on batteries. Complete with Plug, Lead, and snap cord. P & P. 1/6.

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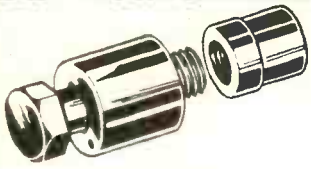

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¾in.	,, B8A, B9A ...	...	9/6 ea.
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2 3/32in.	,, Meter	...	33/2 ea.

Complete Set £9/3/6.

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INDIVIDUAL BOARDS

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ALL ITEMS
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MULLARD TRANSISTORS AND DIODES
Still available as details in the
MARCH
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WIRELESS WORLD
See page 142.
Send for complete list post free.

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Telephone: Walton-on-Thames 21361

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DISPLAYED: £5 per single col. inch.
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No responsibility accepted for errors.

Advertisements accepted up to 15th APRIL for the MAY issue, Subject to space being available.

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AN OVERSEAS CAREER WITH

INTERNATIONAL AERADIO, LIMITED

TO meet the requirements of constant growth and expansion we invite applications from technicians and engineers for an overseas career in North, West and East Africa, the Mediterranean area, the Caribbean, the Arabian Gulf and the Far East. If you have recently completed service in a trade such as Ground Wireless Fitter in the R.A.F. or Radio Electrical Artificer in the Royal Navy or have other experience in the maintenance of HF and VHF communications, RTT and navigational aids, we should be interested to hear from you. Successful candidates would normally spend six weeks at our Radio Training School, Southall, Middlesex, before proceeding overseas, but in some cases staff with suitable qualifications and experience may be offered immediate posting. Overseas staff receive a tax-free salary with married and child allowances if appropriate and accommodation, bachelor or married, is provided free; other benefits include generous U.K. leave and membership of an excellent pension and life assurance scheme.

WRITTEN applications, please, to Personnel Officer, 40, Park St., W.1. [115

RADIO & Television Testers.

FOR City Factory; good rates up to 7/6 per hour; five-day week.

APPLY to Personnel Manager:—
ALBA (RADIO & TELEVISION), Ltd., Tabernacle St., London, E.C.2. [105

MEDICAL RESEARCH COUNCIL.

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ELECTRONICS Technician required, experience with medical or industrial electronics or nucleonic equipment an advantage, good prospects of promotion, salary according to age and experience, £721-£886+ qualification allowance and London Weighting.

APPLICATIONS to the Director, Neuropsychiatric Research Unit, Medical Research Council Laboratories, Woodmansterne Rd., Carshalton, Surrey. [1172

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THE EAST AFRICAN POSTS AND TELECOMMUNICATIONS ADMINISTRATION has vacancies, arising from the retirement of officers on the permanent establishment, for men to serve on contract for a tour of 24 months in the first instance. The job will present a challenge and provide satisfaction and an opportunity of widening experience.

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A generous gratuity—25% of total emoluments—and a disturbance allowance of £200 for married men and £100 for bachelors are also payable. There are also children's educational allowances, free passages and liberal leave on full pay.

MEN are needed in three main fields and the subcategories as shown:—

ASSISTANT ENGINEERS, Grade I, for V.H.F. Specialist posts; Carrier & Telegraph duties; External general duties and Automatic Exchange maintenance.

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CANDIDATES should be aged between 28 and 45 years and possess relevant City & Guilds Certificates, or equivalent qualifications, together with sound experience in their particular field. Those applying for Field Training posts must have had 10 years' experience in telecommunications engineering.

APPLY to Crown Agents, M. Dept., 4 Millbank, London, S.W.1. for application form and further particulars, stating age, name, brief details of qualifications and experience, and quoting reference M2T/52098/WF. [1154

UNIVERSITY OF ST. ANDREWS.

SENIOR TECHNICAL OFFICER: ELECTRONICS AND CHEMICAL INSTRUMENTATION.

APPLICATIONS are invited from persons holding a University degree with specialisation in electronics, or an equivalent technical qualification, for the post of Senior Technical Officer in the Department of Chemistry, St. Salvator's College, St. Andrews. The person appointed will be required to assist with the maintenance and development of instruments used in teaching and research, and to be familiar with the high stability power supplies, amplifiers and oscillators as used in I.R., U.V., N.M.R., E.S.R., and Mass Spectrometers. Salary scale £1,300-£75-£1,600 (efficiency bar) £75-£1975; initial placing according to qualifications and experience; further particulars may be obtained from—The Secretary, University of St. Andrews, College Gate, St. Andrews, Fife, to whom applications should be sent with the name of a referee by 17th April, 1965. [1168

PROGRESS CHASERS & PROVISIONING CLERKS

The Decca Navigator Company wish to recruit the services of the above personnel for work in their Production Control Department. Applicants should be conversant with the workings of such an office and experienced in the Electrical/Electronics field.

These positions carry attractive salaries and excellent opportunities for advancement.

Please write, telephone or call to the:—

Personnel Officer,
The Decca Navigator Co. Ltd.,
88 Bushey Road,
Raynes Park,
S.W.20
Phone: WIM 8011

BABCOCK & WILCOX LTD

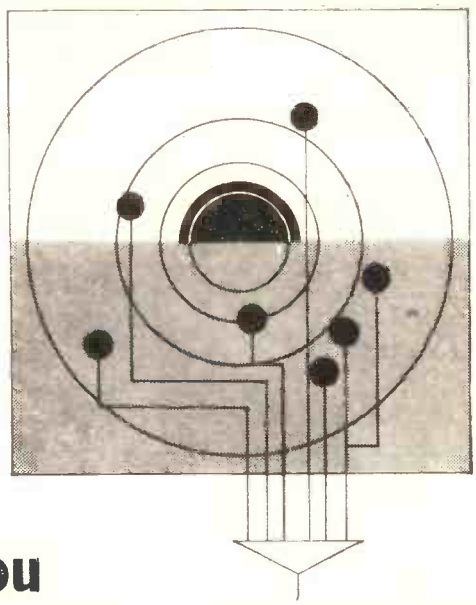
invite applications from

ELECTRONIC ENGINEERS for COMPUTER MAINTENANCE

The successful applicant will be responsible for the maintenance of the equipment in a large analogue computer centre. Education to HNC standard or considerable experience is required, and a knowledge of analogue computers is desirable. Opportunities for programming are available. Salary will be commensurate with qualifications and experience.

Detailed applications should be addressed to the

Assistant Secretary (Ref TBW/RJW)
Babcock & Wilcox Ltd.,
209 Euston Road, London, N.W.1.



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Is this the kind of career you're looking for? If you are between 21 and 29 and have a working knowledge of electronics (e.g. through a Radar/radio Fitters Course, Telecommunications experience or ONC/HNC Electrical or Electronic) we'd like to discuss your plans with you and show you how they could be realised in our rapidly growing organisation.

If you're not quite old enough to have reached the standards we've indicated, we'd still like to hear from you. If you've just left school with 'A' level Maths and English or are studying for ONC Electrical Engineering, we invite you to apply to us. There could be a place for you.

Please send a summary of your education, experience, interests and age to Mr. I. F. Bush, IBM United Kingdom Limited, 101 Wigmore Street, London, W.1., quoting reference CE/WW/155.

You can grow with IBM

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We require trained men for production testing, fault finding and inspection of Modern equipment.

★ **SINGLE sideband equipment**
★ **VHF radiotelephone equipment**
★ **ELECTRONIC telephone exchanges**

We have limited vacancies for more senior and experienced technicians with drive, who can lead small teams. There are also vacancies for men with less experience who can be trained for such work.

Apply: **The Personnel Manager, Cambridge Works Limited, Haig Road, Cambridge.**

WORCESTERSHIRE EDUCATION COMMITTEE.
BROMSGROVE COLLEGE OF FURTHER EDUCATION.
APPLICATIONS are invited for the following post, the appointment to begin on 1st September, 1965.
SCIENCE DEPARTMENT.
LECTURER IN ELECTRONICS to develop courses in electronics in the college; the department has a well-equipped modern electronics laboratory, applicants should have a degree or equivalent qualification with electronics, together with industrial experience in this field.
SALARY scales: Lecturer—£1,670 p.a. to £1,895 p.a., starting point on scale according to qualifications and experience.
APPLICATION forms and further details obtainable from the Principal, College of Further Education, Stratford Rd., Bromsgrove, Worcs., and completed application forms should be returned to him within two weeks of the date of this advertisement. Please enclose stamped, addressed foolscap envelope. [1180

CITY and County of Bristol Education Committee.
Bristol Technical College.
Principal: E. Poole, B.Sc.(Eng.), M.I.Mech.E., M.I.Prod.E.
Applications are invited for the following new post. Appointment from 1st September, 1965.
Department of Navigation. Radio and Radar Lecturer in Marine and/or Aircraft Radio and Radar.
Applicants should preferably hold one or more of the following qualifications, and should have suitable experience in Marine or Aircraft Radio Communications or Electronic equipment in general.
(a) 1st Class P.M.G. Certificate with M.o.T. Radar Maintenance Certificate.
(b) Aircraft Radio Maintenance Engineers' Licences, categories A & B with Radar endorsement.
(c) A Higher National Certificate in Electronics and/or Electrical Engineering, or equivalent.
Salary on scale £1,670-£1,895 (at present under review).
Further particulars and application forms, returnable by 8th April, from Registrar, Bristol Technical College, Ashley Down, Bristol, 7.
Please quote ref. no. T65/14/1. [1165

SOUND reproduction and acoustics; junior engineer of H.N.C. standard required in small laboratory near Watford.—Ring Kings Langley 2955. [1123

SALES ENGINEER

U.S.A. International manufacturers require a Sales Engineer to establish and maintain liaison with designers of radio and other equipment. He will be required to travel extensively and will be based in Philadelphia, Pennsylvania. There is an excellent pension scheme and generous home leave. A moving allowance will be made. Qualifications: Science Degree or other technical qualification. Experience of radio design or similar. Some selling experience would be beneficial.

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Please send details regarding qualifications, age, experience, and present salary to: Box No. 5012, c/o "WIRELESS WORLD."

ELECTRONIC TESTERS and SERVICE ENGINEERS REQUIRED

for interesting work on Radio Transmitters, Receivers, Amplifiers, Test Instruments and General Electronic Apparatus.

If you have a monotonous job and want to better yourself, apply for a post with us which offers:—

Secure Employment.
Scope for Advancement.
Five Day Week.
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Congenial Working Conditions.

Apply to Personnel Department.

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CROMWELL ROAD,
CAMBRIDGE.

THE LONDON HOSPITAL. Whitechapel. E.1.

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ELECTRONICS DEVELOPMENT STAFF.
IMPERIAL COLLEGE, LONDON, S.W.7.
WE have technical staff vacancies for interesting and varied duties in the construction and maintenance of the most modern electronic equipment used in our research programmes. If you have a good practical knowledge of electronics or are a young man working for ONC or HNC, write to me giving full details of your education and career to date. Information about vacant posts in the salary range £630-£1,135 will then be sent to you.
PROFESSOR G. R. Hall, Department of Chemical Engineering and Chemical Technology, Imperial College, London, S.W.7. [1186

PYE CAMBRIDGE WORKS, Ltd., Haig Rd., Cambridge.
* SINGLE sideband equipment.
* VHF radiotelephone equipment.
* HI-FI reproduction equipment.
WE require trained personnel for production testing and fault finding of modern equipment.
WE have limited vacancies for more senior and experienced men with drive, who can lead small teams engaged on this work.
WE have also limited vacancies for persons of less experience who can be trained for such work.
APPLY to: The Personnel Manager. [131

TV service engineer required, good pay, 5-day week, 3 weeks' holiday with pay.—Singer's Radio, Ltd., 261, Harrow Rd., London, W.2. Cunningham 0707. [138

SERVICE engineer required for 16mm sound film projectors; knowledge of amplifiers essential; must be driver.—Burgess Lane & Co., Ltd., Thornton Works, Thornton Ave., Chiswick. Chi. 5752. [1132

PROFESSIONAL ENGINEERS AND TECHNICIANS

with at least two years' experience in British Industry are invited to avail themselves of our Confidential and Free Service.

E.A.L. offers the most efficient and satisfactory way of obtaining alternative employment in the Electronics Industry.

E.A.L. is in contact with all firms in S.E. England and undertakes a complete and thorough survey of any area for suitable vacancies for every engineer registered with us.

For further information please phone or write to:

EAL TD

Electronics Appointments Ltd.,
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Cambridge Circus.
London, W.C.2
Phone: TEMple Bar 5557/8

YORKSHIRE IMPERIAL

YORKSHIRE IMPERIAL METALS LIMITED

have two vacancies in their

ELECTRICAL ENGINEERING DEPARTMENT

1. Electronic Maintenance Supervisor
2. Electronic Maintenance Technician

The work will involve the maintenance, calibration and installation of a wide variety of industrial electronic equipment.

Applicants must have a knowledge of solid state circuiting for the supervisory post. Some experience is also desirable in one or more of the following fields:

1. Non destructive testing equipment
2. Machine Control
3. Communications

Consideration will also be given to men with experience of electronics in the Services.

The Company is the largest of its kind in Europe and offers attractive conditions of employment which include a Pension and Life Assurance Scheme and Profit Sharing Scheme.

Applications, giving details of age, experience, qualifications and present salary, should be marked "Reference 6168—Confidential" and addressed to:

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P.O. BOX 166, LEEDS.

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Collects those methods of solving complicated problems which have been developed by research mathematicians to make the fullest use of all types of modern automatic high speed computing machines. The book should prove invaluable to programmers, mathematicians, engineers, physicists, chemists and scientists who are interested in the applications of electronic computers to the solution of their own problems.

42s net, by post 42s 11d.

Introduction to Laplace Transforms for radio and electronic engineers

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Presents the theory of the Laplace transformation in easily understood language, dealing with electrical circuits from the very first paragraph to the stage when transforms are used to investigate transient conditions. The first part of the book is designed for home study while the second half is designed as an introduction to more advanced texts.

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A CHALLENGING and PROGRESSIVE CAREER is offered in the Engineering of ADVANCED COMMUNICATIONS SYSTEMS and allied techniques

H.M.G.C.C.

invites Applications from Candidates for Appointment as Experimental Officers or Assistant Experimental Officers in an expanding Engineering Group at Hanslope Park, Buckinghamshire.

Candidates for EXPERIMENTAL OFFICER appointment will normally be at least 26 years of age, hold a Pass degree, Dip. Tech., or H.N.C. and have several years' experience in communications or general electronics. Salary commensurate with age and ability up to £1675 per annum.

Candidates for ASSISTANT EXPERIMENTAL OFFICER appointment will be at least 18 years of age and have passed two G.C.E. 'A' levels in scientific subjects. Salary commensurate with age and ability up to £1201 per annum.

Hanslope Park is situated in pleasant country surroundings where houses are readily available. Easy access to London by road or rail.

Encouragement is given to staff who wish to extend their knowledge by attending specialist courses.

Write to:- The Personnel Officer, H.M.G.C.C., Hanslope Park, Wolverton, Bucks. - giving age, qualifications and a summary of experience. Candidates and both their parents must have been British subjects at all times since birth.

TESTERS

required for interesting work on L.F. and H.F. Transmitters. Previous fault-finding experience essential.

The positions available would be of special interest to persons employed in the fault-finding and repair of television who are keen to establish themselves in a position that offers:

- ★ Satisfactory employment
- ★ Five-day week
- ★ Good prospects of advancement
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Apply: Personnel Manager

Multitone Electric Co. Ltd.

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Applications are invited from electronics Engineers for development of television receivers and associated electronic equipment from conception, following through all phases to production. Applicants should preferably have experience in a similar capacity, i.e. radio or television design/development. Engineers who have a wide experience of servicing will be given consideration, depending on standard attained. Applicants should be in age group 25/35 years and must be capable of working on own initiative. Housing assistance may be given.

Apply giving details of age, experience, qualifications, if any, present salary etc., **Personnel Manager, Ultra Radio & Television Ltd., Fareham Road, Gosport.**

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QUALIFIED engineer required for responsible and interesting work on specialised audio-frequency equipment.—A. Peters & Sons, Ltd., 51, Gell St., Sheffield, 3. [1174

JUNIOR recording engineer required by London studio, keen interest in audio and ability to drive essential; apply stating age and experience to—Box WW 1171, Wireless World.

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SERVICE technicians and trainees for maintenance work on all kinds of audio equipment, required in the London area; pension scheme.—Apply, Mr. J. Vaughan, Dictograph Telephones, Ltd., Abbey House, Victoria St., London, S.W.1. Tel: ABB 5572. [1131

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RADIO Engineers and Mechanics with specific workshop experience in ADF/HF, VHF or ILS/VOR. 40-hour week, salary according to experience and ability, pension scheme.—Apply: Managing Director, Air Transport (Charter) (C.I.), Ltd., Willow Rd., Poyle Trading Estate, Colnbrook, Bucks. [1182

TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications, receivers and transmitters; successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details, to Personnel Officer, Redifon, Ltd., Bromhill Rd., S.W.18. [124

GRAMPIAN REPRODUCERS, Ltd., require Senior Test Engineer to take charge of test department; must be fully conversant with sound amplification systems.—Apply Dept. R.B., Hanworth Trading Estate, Feltham, Middlesex. [1115

TV relay senior engineers required, able to control small teams installing co-axial aerial systems, North London area, very good rates of pay, bonus, overtime, etc.—Apply: Mr. Henderson, Imhot's, 9a, Mildmay Grove, N.1. Can. 1281. [1181

EXPERIENCED technical authors and specification writers required for well paid staff appointments in Reading and Manchester offices, and various parts of the country; we are an expanding company operating good sickness, pensions and life assurance schemes. —Apply to Engineering & Technical Publications, Ltd., 1-3, Greyfriars Rd., Reading, or 3, Chepstow St., Manchester, 1. [139

MINISTRY OF DEFENCE (NAVAL) VACANCIES FOR PRODUCTION INSPECTORS

There are vacancies in the Navy Department Production Pool for Production Inspectors (Technical Class Grade II) and Assistant Production Inspectors (Technical Class Grade III) for a wide range of duties concerned with the production of equipment in the fields of Ship Propulsion, Radio Communication, Sonar, Radar, Missile and Weapon Control and Computers. The work in general includes the preparation of production specifications, technical liaison with production contractors, test/ and inspection, system test, calibration, qualification approval and liaison with research and development teams. There are also vacancies for Technical Authors (Technical Class Grade II) who are required to prepare technical handbooks used in the maintenance of the above equipment in the Fleet.

LOCATION: The posts are at Portsmouth, Bath, Copenacre (Wilts), Portland and certain posts concerned with inspection during manufacture are mainly in the London, Midland and Northern areas. The posts at Portland are mainly concerned with the production of Sonar Equipment whilst those at Portsmouth are mainly concerned with Radar and Communication Equipment. The posts at Bath and Copenacre cover the whole range of equipment but the work at Copenacre is mainly concerned with test, inspection and calibration.

QUALIFICATIONS: Full apprenticeship plus practical experience in the above field(s), and possession of an ONC (or equivalent) in mechanical and/or Electrical Engineering. Possession of a higher technical qualification, eg. HNC, would be an advantage.

SALARY SCALE: National rates are:—

Technical Class Grade II	£1,091 by four annual increments to £1,244.
Technical Class Grade III	£913 (age 26) by six annual increments to £1,091

(The above rates are under review and posts in the London area attract an allowance)

Prospects of pensionable employment and of promotion to higher grade posts.

APPLICATIONS: Write to **SUPERINTENDENT OF THE PRODUCTION POOL, MINISTRY OF DEFENCE (NAVY) OFFICES, EMPIRE HOTEL, BATH, SOMERSET,** stating age, nationality and full details of qualifications and experience.

GET INTO COMPUTERS NOW

Opportunities in English Electric Leo Marconi's Field Engineering Services

Commissioning Engineers are needed for the final testing and installation of real-time computers and industrial process control equipment. Relevant experience is desirable. The jobs are based in Kidsgrove but periods away will be necessary including perhaps the opportunity of short stays overseas. Kidsgrove is in pleasant countryside on the border of Cheshire and Staffordshire; housing in the area is inexpensive and easy to find.

Maintenance Engineers are needed at bases in London or Kidsgrove. The work is concerned with real-time computers and industrial process control equipment and is interesting and varied. Applicants must be willing to travel on call from base.

Site Computer Engineers are needed to maintain computers on sites in the London area, Home Counties, South Glasgow and elsewhere. Previous experience is not essential and men who have been trained on radar equipment are especially invited to apply. Those who work shifts receive financial compensation.

These posts offer good training, attractive allowances, excellent prospects, staff status and voluntary participation in a good pension scheme. Essential qualifications are keenness, willingness to take responsibility, electronic experience and general intelligence. Experience with transistors and pulse circuitry would be an advantage. The suggested age range is 25 to 35 but others would be considered.

To arrange an interview if you are in London, please telephone Mr. C. G. Ashby on ELGar 2894 any working day between 2 p.m. and 5 p.m. Otherwise please write giving brief details of age, qualifications and experience to:

The Technical Staff Officer,
Dept. WW.L. 39,
English Electric-Leo-Marconi Computers Ltd.,
Kidsgrove, Stoke-on-Trent, Staffordshire.

ENGLISH ELECTRIC LEO MARCONI

ELECTRONIC INSPECTORS
and
TEST ENGINEERS
required by
DECCA RADAR LIMITED
at Chessington, Surrey.

SECURITY
WIDER EXPERIENCE
REAL PROSPECTS
FRIENDLY TEAM-WORK
HIGH WORK STANDARDS

If these factors are high priorities for you, they are for us too, and we are proud of our record.

We have an extensive and interesting programme of work with vacancies for experienced staff at many levels.

There are new buildings and equipment, and good conditions of employment.

Please apply for interview giving brief particulars of experience, qualifications and present salary to:

Personnel Officer, 9 Davis Road, Chessington, Surrey.

WEST HAM COLLEGE OF TECHNOLOGY
Romford Road, Stratford, E.15.
A one day symposium on
FIELD EFFECT TRANSISTORS
will be held on Wednesday, 19th May, 1965.

Papers will be read by representatives from industrial firms engaged in the fabrication of Field Effect Transistors, and time will be allocated for discussion.

The subjects to be covered will be as follows:—
The Theory of the Operation of Field Effect Transistors
Present Day Field Effect Transistors
The future for Field Effect Transistors
Application of Field Effect Transistors

Full details may be obtained from the Head of the Electrical Engineering Department, West Ham College of Technology, Romford Road, London, E.15.

95, The Grove, Stratford, E.15. R. Openshaw, Chief Education Officer

---

AIRCRAFT Radio Maintenance Engineer (preferably with "A" licence and with aircraft electrical and instrumentation experience) required for work on H.S.748 and D.C.3 aircraft. National Joint Council wages and conditions and pension scheme. Applications should be addressed to the Technical Manager, Skyways Coach Air Ltd., Lympne Airport, Near Hythe, Kent. [1155

THE LONDON HOSPITAL, Whitechapel, E.1. requires a young man about 18-20 to assist with maintenance and construction of electronic equipment in E.E.G. department. Previous medical experience not necessary, but familiarity with electronic techniques essential. Salary up to £714 according to age and experience. CONTINUED study encouraged, and facilities provided. —Tel. Bishopsgate 5454, ext. 211, or write with names of 2 referees, to the House Governor, immediately. [1176

SEMI-CONDUCTOR Power Conversion Equipment.—A young engineer or technical assistant is required for the development work on transistor and thyristor inverters and allied equipment, in the London area; the programme calls for a very substantial expansion of this side of the Company's activities; an H.N.C. or an O.N.C. with the intention to proceed to the H.N.C. is desirable.—Apply to Box WW 1169, Wireless World.

RADIO MECHANICS
SOUTH AFRICA

STANDARD TELEPHONES & CABLES (SA) (PTY) LTD.

have several vacancies for Radio Mechanics who have experience in Naval Shore Wireless High Power Transmitters or similar equipment who will undertake maintenance of a major installation in the Cape Area.

We can offer a five year renewable contract, a five day working week with additional pay for overtime and shift work, and three weeks' paid holiday each year.

The company operates a pension scheme, sick benefits and other fringe benefit schemes.

Low income tax and cost of living ensure a reasonably high standard of living.

South Africa Settlement Association (1820 British Settlers Association), will advise successful candidates on all questions relating to emigration, housing, living conditions, passages, other formalities.

STARTING SALARY RANGE FROM £1,000—£1,500 p.a.

Write for an application form to:

Box No. BR 620

Austin Knight Ltd., John Kirk House, 31-32 John Street, London, W.C.1.

ELECTRONIC WIREMEN

required for the construction, wiring and modification of a varied range of Radio and T.V. Test Equipment. Good workmanship is essential and applicants are required to have previous experience of similar work together with a basic theoretical knowledge. 5-day week, sick benefits and superannuation scheme. Please apply in writing to the Production Supervisor, Radio Rentals (U.K.) Limited, Works Centre, 14, Beresford Avenue, Wembley, Middlesex.

SERVICE engineers required for installation and maintenance of telephone answering and recording equipment in the London area, vehicle provided interviews locally; please write stating age and salary required to.—Personnel Officer, Ansafone, Ltd., Frimley Rd., Camberley, Surrey. [116

DEVELOPMENT engineers, senior and junior with experience in circuit design of radio receivers, audio equipment and tape recorder; particular emphasis on transistor applications, qualifications desirable, but good experience in these competitive fields important, initiative to complete projects through to production essential, staff appointments, excellent salaries for candidates of right qualifications or experience.—Write with full details to: Technical Director, Halroy Products, Ltd., Headstone Lane, Harrow, Middlesex. [117

AVIONICS Engineer.—Applications are invited to take charge of radio, electrical and instrument maintenance of small fleet of modern prop-jet aircraft based in South of England. Applicants should possess at least an "A" Aircraft Radio Maintenance Engineers Licence and have aircraft electrical and instrumentation experience acceptable to the Air Registration Board to enable them to obtain applicable "X" Aircraft Maintenance Engineers Licences in due course. Good salary for successful applicant with qualifications and experience. Apply giving full experience and salary expected to—Box WW 1167, Wireless World.

ASSISTANT Lecturer, Grade B, in Electronic Engineering required at Cambridgeshire College of Arts and Technology from 1st September, 1965, to teach in Electrical Technicians and CGLI Electronic Servicing courses. Candidates must have at least an HNC or CGLI full Technological Certificate, together with industrial experience in the development or servicing of electronic instruments. Some teaching experience also desirable. Salary will be in accordance with the Burnham Scale for Grade B Assistant Lecturers: £830–£1,450. Further particulars and application forms from the Principal, Cambridgeshire College of Arts and Technology, Collier Road, Cambridge. [116

INSTRUMENT MECHANIC required at Stourport Power Station, Worcestershire. Excellent conditions of service. Basic salary £8·5 per annum (£16 0s 3d per week) plus 6/- per week productivity bonus. Dependent upon the working pattern the salary earned could be £1,094 per annum. A service increment of 8/- per week is payable after 2 years' service. Applicants should have had experience of the maintenance and calibration of a wide range of electronic and/or physical industrial instruments. Men with experience of aircraft instrument maintenance will be considered. Apply in writing quoting vacancy number 150/65MR and giving details of age, experience and present position to the Station Superintendent, Stourport Power Station, Severn Side, Stourport-on-Severn, Worcs. by 29th March, 1965. [115

SITUATIONS WANTED

ELECTRICAL instrument mechanic seeks sub contract work, assembly/wiring, electro/mechanical equipment.—Box WW 85, Wireless World.

MINISTRY OF DEFENCE (ARMY DEPT.)
requires
TECHNICALS GRADE III

for a wide variety of duties dealing with optical electrical, telecommunication and electronic equipment, in service with the Army. Vacancies exist within the REME organisation in or near the following locations:

WOOLWICH: Experience in optical instruments required for some vacancies. **READING, MELTON MOWBRAY, MALVERN, NOTTINGHAM, BURSCOUGH (RAOC), DONNINGTON** (Salop), **ANGLESEY, MIDDLE WALLOP,** Hants—Army Air Corps Centre. Experience in mechanical aircraft engineering required.

Applicants should have served an apprenticeship (or have had an equivalent period of training) followed by 3 years' practical experience.

Applicants must possess O.N.C. or hold an equiv. qualn. Successful completion of an Artificers Course in REME or Foreman of Signals course may be accepted in lieu.

National salary scale for a Technical Grade III is £913 to £1,091 p.a. (minimum linked to age 26) plus London Weighting of £45 to £50 where applicable.

APPLICATION FORMS from **Manager (PE.1707), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon St., London, E.C.4.**

SALES MANAGER

Owing to internal promotion we wish to appoint a Sales Manager for the expanding Acoustic Division of Plessey-UK Limited at Havant.

Applicants should have sound technical and specialised knowledge of loudspeaker and other acoustic devices. This position involves high level commercial and technical liaison in the U.K. with major manufacturers, and therefore, commercial experience in this field is essential.

A good salary and a car will be provided for the successful applicant, together with the normal fringe benefits associated with a modern organisation. It will be an advantage if the person appointed is resident in the Greater London area.

Applicants are invited to send brief relevant details to the

Regional Personnel Manager,

Plessey-UK Limited,

New Lane, Havant, Hants.

Plessey UK

SYSTEM TEST ENGINEERS

PYE TELECOMMUNICATIONS LTD. have vacancies for varied and interesting test work on custom-built Control Systems for VHF/UHF Radio Schemes.

Knowledge of radio and/or line communications techniques is essential.

Apply to the Personnel Manager, Pye Telecommunications, Newmarket Road, Cambridge

SYSTEMS ENGINEERS

PYE TELECOMMUNICATIONS LTD. of CAMBRIDGE

Have vacancies in a department which is engineering line and control systems associated with Radio-telephone Schemes.

Experience of line communications and some knowledge of radio-telephone equipment is essential.

A good salary will be paid and there is excellent opportunity for advancement in this rapidly expanding Company.

Apply :— **Personnel Manager, Pye Telecommunications Ltd. Newmarket Road, Cambridge.**

SYSTEMS DESIGN ENGINEERS

PYE TELECOMMUNICATIONS

require:

SYSTEMS ENGINEERS FOR THE DESIGN OF CONTROL SYSTEMS FOR USE WITH RADIO COMMUNICATIONS NETWORKS

Applicants must be experienced in the design and maintenance of telephone switching equipment or multi-channel telephone systems and be familiar with the principles involved.

Experience of the application of such systems to radio bearer circuits is desirable but not essential.

Corporate membership of the I.E.E. or equivalent is desirable but applicants without such qualifications who can prove wide experience up to a recent date will be considered.

Apply to: **Personnel Manager**
Pye Telecommunications Ltd.
Newmarket Road, Cambridge

S.O.S. from Sweden! Engineer, 35, Hungarian in exile, entirely devoted to sound, seeks position within the British Hi-Fi, record or broadcasting industry due to the minimal audio activity in Sweden; has mechanical and electrical qualifications and more than ten years of private practice; special interest: tape recorders; for more information contact—B. Tary, Väringavägen 16, Djursholm 1, Sweden. [81

BOOKS, INSTRUCTIONS, ETC.

TWENTY-SIX bound volumes "Wireless World" 1932 to 1953, 1954 to 1960 complete; unindexed, loose, as issued.—Offers to Box W.W.74, Wireless World.

WEBB'S log books for recording signals heard and worked, 112 pages, 9¾×8in, approved format, semi-stiff covers, excellent value 7/6 post free, or callers 6/5.—Webb's Radio, 14, Soho St., London, W.1. [106

MANUALS, circuits of all British ex-W.D. 1939-45 wireless equipment and instruments, from original R.E.M.E. instructions; s.a.e. for list, over 70 types.—W. H. Bailey, 167a, Moffat Rd., Thornton Heath, Surrey. [143

ARTICLES FOR SALE

FERROGRAPH 5/AN (March 1964, £62, no offers (London).—Box WW 110, Wireless World.

LARGE quantity miscellaneous radio and electronic spares, offers.—Ham 9632. [1166

PHILIPS X-ray image intensifier with P.S.V.; excellent condition, tube very good, £300.—Box WW 76, Wireless World.

VIBRATOR G.E.C. Vem 5.2, complete with 2 1kW amplifiers, driver unit and audio osscillators; £350.—Romford 44473. [1157

TELEVISION sets, not working, for callers only, 17in £1/10, 21in £3/10, 14in mains portables £2/10.—'Phone Bournemouth 26849 [1178

LAFAYETTE International Tape; example: 7 2,400ft. polyester, 22/6; p. & p. 2/-; wide rang s.a.e. list.—Leda Tapes, 27, Baker St., W.1. [

PHILIPS relay bargains: e.g. 800+400Ω 6 gold c 7/6, silver and platinum also in stock, s.a.e. list.—J. Taylor, 26, Bewlay St., York. [

SPIRE, plain, self locking nuts, screws and rive large quantities wanted for cash.—L. Kayser, 1 Highbury Quadrant, London, N.5. Canonbury 67 [

RADIO Luxembourg (London), Ltd., have for sale E.M.I. 5-channel mixer and a Philips EL 35 7½in/sec recorder.—38, Hertford St., London, W.1. [11

TRANSISTORS: AF.114/115/116/117, 4/- ea.; 2501 10/- ea.; AF.127, 5/- ea.; silicon diodes, 200P.I 4amp 2/6 each.—Pattrick & Kinnie, 81, Park La Hornchurch, Essex. Romford 44473. [11

700,000 semiconductors, radio manufacturer's surpl AF/RF transistors, silicon rect., diodes, etc., off accepted for part lots; lists and details to Box W.W Wireless World.

QUAD complete stereo system, electrostatic speak GL70P transcription, Empire 880P head, MIC, new and guaranteed; £240, value nearest £170.—P 2808. [

METERS 7KV electrostatic 3½in £3 ea.; 3.5 2½in rd. 30/- ea.; 500 Micro-Amp 2½in rd. 1 ea.; 115V 400 g.p.s. 2½in rd. 25/- ea.; 1-0-1 M 4in rd. 25/- ea.; p.p. 2/6.—Pattrick & Kinnie, 81, P Lane, Hornchurch, Essex. Romford 44473 [

UNISELECTORS (ex. equipment) 25 way, 4-ba 22/6; 6-bank, 27/6; 8-bank, 32/6 ea.; p.p. 2 latest type (smoke grey) telephone handsets, 10/- p.p. 1/-—Pattrick & Kinnie, 81, Park Lane, Ho church, Essex. Romford 44473. [11

ARTICLES WANTED

WANTED, Air Ministry surplus aerial masts t 50, 30ft high, reference No. 10B/1600.—Staray Ltd., King's Ride, Ascot, Berks. [11

WANTED, C.R.T. regunning Glasswork mach details and price required.—Midland TV Servic High St., Harbury, Leamington Spa., Warwicks. [

WANTED, all types of communications receiv and test equipment.—Details to R. T. & Electronics, Ltd., Ashville Old Hall, Ashville Rd., L don, E.11. Ley. 4986. [

URGENTLY wanted, new valves, transisters, radi cameras, binoculars, tape recorder and tap watches, any quantity.—S. N. Willetts, 43, Spon La West Bromwich, Staffs. Tel. Wes. 2392. [

TAPE RECORDING ETC.

SAVE on cost of hi-fi. See Audio Supply notice (adv No. 111). [

"SLEEP learning," the book essential for all ahead people.—Send 6/6 to York House, H dersfield. [

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TEST TECHNICIANS

AEI Industrial Group has vacancies at Rugby for men to undertake testing and fault finding of

ELECTRICAL AND ELECTRONIC CONTROL GEAR

being manufactured for automated Mining Equipment, Power Stations, Rolling Mills, Ship Propulsion, Machine Tools, and Automated Industrial Systems.

Those with experience of T.V., Radio, Telecommunication, Electronic and Control Circuitry, preferably holding ONC, HNC or a similar qualification are required.

A period of training will be given where necessary. Pensionable posts under staff conditions will be offered to suitable applicants.

Good prospects of advancement.

Applicants are invited to write to-

Staff Manager (Manufacture)
Associated Electrical Industries Ltd
RUGBY

INDUSTRIAL

AUSTRALIA offers CAREERS IN METEOROLOGY for

RADAR and RADIO TECHNICIANS

The Australian Meteorological Bureau, an organisation of high international standing, controls weather stations throughout the Australian continent and adjacent territories. The World Meteorological Organisation has recently decided to locate the only weather information centre for the Southern Hemisphere at Melbourne. Because of the rapid expansion of the Bureau, and the even more rapid development of forecasting techniques, there are vacancies for Observers (Radio) with excellent prospects for advancement.

SALARY RANGE

£1227-£1395 (Australian)

QUALIFICATIONS

Passes in Mathematics and Physics at least to third year secondary school level, preferably at G.C.E. "O" levels. Qualified as Technician in radar, television, radio or associated fields; experience in the maintenance of electronic equipment, involving one or more UHF, VHF, and microwave frequencies, pulse techniques, frequency modulation.

ELIGIBILITY

Applicants must be British subjects, eligible for permanent residence in Australia, and in good health.

TRAINING

Free training for 31 weeks will be conducted on full salary in Melbourne. Temporary accommodation will be available upon arrival at Melbourne.

DUTIES

Maintain and operate electronic equipment; take meteorological observations. The equipment comprises weather surveillance and wind finding radars, atmospheric D/F equipment, radiosonde and other telemetry equipment.

TRAVEL

Travel to Australia will be arranged.

COMPLETION OF TRAINING

Upon satisfactory completion of training, officers will be transferred to field offices. Residences are provided at most of these posts, except in the seven capital cities, and a suitable district allowance is paid at remote or difficult posts. Trainees who hold G.C.E. "O" level in a suitable range of subjects or the equivalent, will be eligible to apply for six months' supplementary training in aeronautical meteorology, to qualify for promotion to higher positions.

GENERAL

Shift allowances are payable in addition to salary. Recreation Leave of four weeks per annum plus additional leave and assistance with fares to proceed on leave from remote areas is provided. Selected applicants will be permanently appointed to Commonwealth Public Service. Long service, sick leave and superannuation benefits applicable.

ADDITIONAL INFORMATION

and application forms may be obtained from the Public Service Board Representative, Reference R.1, Australia House, Strand, LONDON, W.C.2.
(Telephone TEMple Bar 2435, Ext. 586 or 461) with whom applications close on 19th April, 1965.

PYE TELECOMMUNICATIONS LTD
Have vacancies in
CAMBRIDGE

VHF TEST ENGINEERS

Experience of V.H.F. Transmitters and Receivers essential. Men who have had training in the Services would be suitable. Good rates of pay and promotion. Applicants who wish to seek a career with Europe's leading Radiotelephone manufacturers should apply to:—

Personnel Manager
Pye Telecommunications Limited.
Newmarket Road,
Cambridge.
Tel: Teversham 3131

INSTRUMENT MECHANICS

required by the Central Electricity Generating Board at WEST THURROCK Generating Station, Grays, Essex.

Salary £871/10/- per annum (£16/14/4 per week) plus 6s. per week Productivity Bonus plus a Service Increment after two years' service of 8s. per week.

Conditions include a 42-hour week, optional superannuation scheme, generous holidays and sick pay and good canteen facilities.

Applications to be sent to the STATION SUPERINTENDENT, CENTRAL ELECTRICITY GENERATING BOARD, WEST THURROCK GENERATING STATION, STONE NESS ROAD, GRAYS, FSSEX.

A UNIQUE Buy! Recording tape, top brand, 7in 2,400ft D.P., 25/-; 5¾in 1,200ft, 19/6; p. & p. 1/6 per spool; bargains in all sizes; s.a.e. for list; we repair, buy and sell recorders.—E. C. Kingsley & Co., Ltd., 132, Tottenham Court Rd., London, W.1. Euston 6500. [113

TAPE/DISC/TAPE transfer editing; duplicating, it quality and durability matter (especially with LPs from your precious tapes) consult Britain's oldest transfer service.—Fund raising records published for schools, musical societies (tax free).—Sound News Productions, 10, Clifford St., London, W.1. Reg. 2745. [108

NEW GRAM AND SOUND EQUIPMENT

GLASGOW.—Recorders bought, sold, exchanged; cameras, etc., exchanged for recorders or vice-versa. —Victor Morris, 343, Argyle St., Glasgow, C.2. [120

RETURN of post service: record changers, players and tape decks, some at special prices; speakers, Martin type kits, Mullard amplifier kits, Jason tuners, test meters, all in stock, H.P. available; send for free illustrated lists, postal only.—Watts Radio, Ltd., 54, Church St., Weybridge Surrey. Tel. 47556. [114

REDIFFUSION TELEVISION LIMITED
have vacancies for

TECHNICAL ASSISTANTS

for training as

TELEVISION BROADCASTING ENGINEERS

Minimum acceptable qualification is a good Higher National Certificate (Electronics). Commencing salary £1,062 per annum. Apply in writing to:—

Assistant General Manager (Staff),
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Television House, Kingsway, London, W.C.2.

MINISTRY OF DEFENCE

(Air Force Department)

requires Examiners (Technical Class Grade III) in the Radio division of the Aeronautical Inspection Service.

LOCATION. Vacancies exist mainly at Henlow, Western and Northern England, S. Wales and N. Ireland.

DUTIES. At Henlow the calibration of a wide range of electronic equipment and the compilation of calibration manuals. At other units, the technical supervision of staff, the inspection and testing of equipment and submission of inspection schedules.

QUALIFICATIONS. Applicants must be British subjects. A full five year apprenticeship or equivalent training. Experience in the development, manufacture, inspection, maintenance or testing of wireless or radar equipment. O.N.C. (Elect.) or City and Guilds Intermediate Certificate plus Radio II or an equivalent qualification. Applicants must be prepared to serve a tour or tours of 2 or 3 years duration overseas.

APPOINTMENTS will be unestablished. Establishment is by open competitions which are held periodically.

SALARY. National scale £798—£1,091. Age 28 and over start at £975. Prospects of promotion to higher grades with a maximum of £1,767. Applications and further details from Ministry of Defence C.E. 3f (Air), Sentinel House, Southampton Row, W.C.1.

THE MINISTRY OF DEFENCE (ARMY DEPARTMENT) invites applications for interesting Grade V ENGINEERING appointments in the BRITISH FORCES BROADCASTING SERVICE overseas in Aden, Benghazi, Tobruk, Tripoli and Cyprus.

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Operation and maintenance of MF, HF, VHF, Transmitters, Studio equipment and generating equipment. Appropriate ONC, City and Guilds, or equivalent qualifications are necessary.

SALARY SCALE (under review) for Grade V staff is £739 to £1,039 p.a. In addition generous non-taxable Foreign Service Allowances are paid according to location. Candidates must be at least 21 years of age.

For further details and Application Form please write to:—

The Director (EW),
British Forces Broadcasting Service,
Kings Buildings,
Dean Stanley Street,
London, S.W.1.

SOLARTRON

SERVICE ENGINEER

Resulting from the unification of our Service Department on one location, vacancies have arisen at our Farnborough factory for Engineers to service electronic instruments. These include thermionic power supplies, transistorised power supplies, digital voltmeters, signal generators, oscilloscopes, and servo equipment. We would welcome applications from experienced T.V. Service Engineers qualified to C. & G. final standard or R.T.E.B. standard.

Please apply:

Miss C. J. Read, Personnel Officer,

THE SOLARTRON ELECTRONIC GROUP LTD.,

Victoria Road, Farnborough, Hants.

Telephone: Farnborough 3000

FOR the best in Hi-Fi sound and tape recording equipment. Sound reinforcement systems for schools, churches and professional organizations. Rapid postal service anywhere in the world. Good quality part exchanges welcome. H.p. facilities. Specialist Audio Service Dept. Records all labels. Suppliers to schools, universities, atomic energy authority, leading architects and broadcasting organizations.—Visit us at No. 70. Lambda Record Company Limited, 70, Liverpool Rd., Liverpool, 23. Tel.: Great Crosby 4012. [2868

NEW COMPONENTS

MAINS transformers for sale due to uncompleted project, input 0-205-225-245V 50 c/s, output 350-0-350 at 200 M/A, 6.3V at 4A, 5V at 3A, 50 available at £2 each or £90 the lot.—Write: Music Hire (Yorks.), Ltd., 40, St. Paul's St., Leeds, 1. [1162

ALL T/V spares, LOPTs our speciality, any make Alba-Ultra, mostly makers' exact replacements, e.g., EKCO T221/231/284/310/311, 69/9; T330/331, 72/3; Murphy V240/250, 75/-; 270/280/310/470/540, 85/-; p.p. 4/-, c.w.o. or c.o.d.; Ekco/Ferranti Shrouds will save you £££s, standard 14/9, de luxe 19/6; s.a.e. for enquiries or telephone Tid. 5394 (day), Rod. 7917 (night); orders despatched same day; T.C.S. Mail Order Department now at Brockley T/V, 28, Brockley Cross, S.E.4. Callers welcome. [144

VACANCIES IN THE COMPOSITE SIGNALS ORGANISATION

A number of vacancies offering good career prospects, exist for

RADIO OPERATORS (Male)

Candidates should have a minimum of two years' practical Radio Operating experience.

Write, giving details of Education and Qualifications to:—

Recruitment Officer (CSO/3), Government Communications Headquarters, A Block, Priors Road, Cheltenham, Glos.

B.B.C.2, TV, RADIO, TAPE REC., SPARES. B.B.C.2 625. Complete conversion kits, or tuners and IF panels separately; send for free lists. TV Signal Booster Units, Labgear B1/3, or UHF 75/-, masthead 105/-, Perdio UHF 70/-, post free; L.O.P.Ts., Philips, Stella 1768, 8617, etc. 98/-, Ekco/Ferranti U25 types 48/6, Ekco Ferranti U26 and Perspex types 62/6, Ferguson 306, 308 48/6, 406, etc. 65/6, Sobell, TS17 48/6, 171, etc. 67/6, Pye V4 to V700, etc. 62/6, post 3/-; also Alba, Cossor, Decca, G.E.C., K.B., Invicta, Pam, Philco, McMichael, R.G.D., Dynatron, Emerson, Regentone, Ultra, H.M.V., Marconi, etc.; Scan coils, frame O/P, Frame osc., Line osc., mains, sound O/P transformers, width/lin coils, mains droppers, dual controls, etc.; Tuner Units, Fireball, incremental, turrets, channel coils; CRTS, Mullard, Mazda, Brimar, Emiscope 14in and 17in 85/-, 21in 120/-, etc., carriage 10/-; Tape Recorders, belts, heads, motors, etc.; salvaged components—large selection clean, serviceable turrets, transformers, etc.; enquiries invited, C.O.D. 2/6. MANOR Supplies, 64, Golders Manor Drive, London, N.W.11. Callers, 589b, High Rd. (near Granville Rd.), N. Finchley, N.12. Hil. 9118 (day), Sve. 4032 (evg.); open all week incl. Sat. [101

VALVES

VALVE cartons by return at keen prices: send 1/- for all samples and list.—J. & A., Boxmakers, 75a, Godwin St., Bradford, 1. [116

SOLARTRON

PROTOTYPE WIREMEN

At our new Farnborough factory we are selecting Prototype Wiremen for posts in our Data Handling, Data Logging and Analogue Computer Systems Assembly areas.

Applications are invited from experienced wiremen able to work from circuit diagrams and engineers' sketches.

Salaries are progressive and will commence in the range of £15 to £18 15s. per week according to experience.

We work a 5 day, 40 hour week. Membership of our non-contributory pension fund and sick pay scheme is automatic.

Please apply:

Miss C. J. Read, Personnel Officer,

THE SOLARTRON ELECTRONIC GROUP LTD.,

Victoria Road, Farnborough, Hants.

Telephone: Farnborough 3000

IMPERIAL CHEMICAL INDUSTRIES LIMITED

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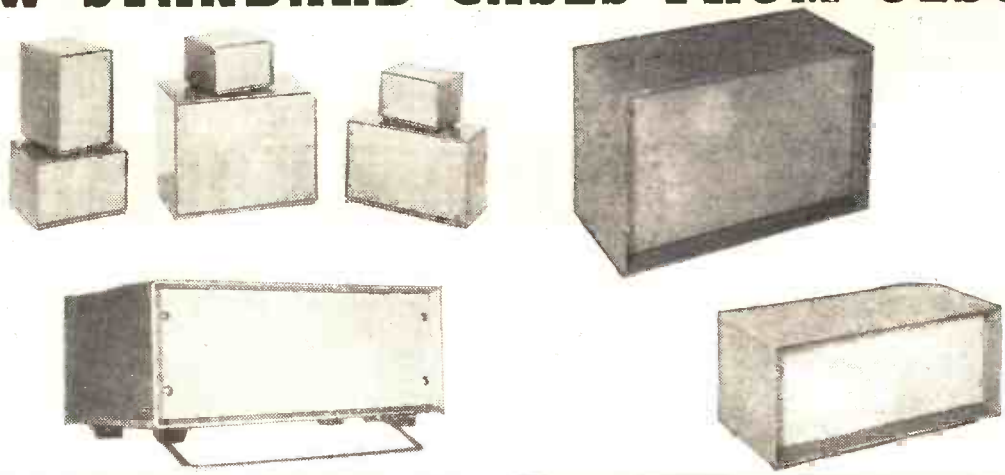

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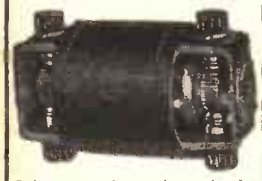

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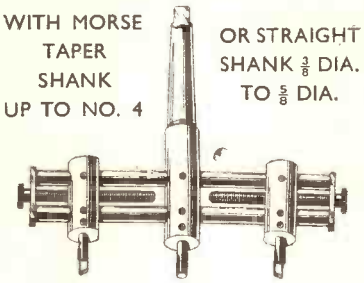

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INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages

PAGE

Acoustical Mfg. Co., Ltd. 12
Adcola Products, Ltd. Cover iii
A.D.S. Relays, Ltd. 42
Advance Electronics, Ltd. 48
A.E.I., Ltd. 57
A.E.I. Cables, Ltd. 68
Airmec, Ltd. 77
Airmed, Ltd. 42
Akurate Eng. Co., Ltd. 151
Amalgamated Wireless (Australasia), Ltd. 22
Amplivex, Ltd. 76
Anders Electronics, Ltd. 10, 69
A.N.T.E.X., Ltd. 9
A.P.T. Electronics, Ltd. 55
Armstrong Audio, Ltd. 89
Audix, B.B., Ltd. 147
Avo, Ltd. 1
Avon Communications & Electronics, Ltd. 84

Batey, Wm., & Co. 90
Beckman Instruments, Ltd. 52
Belling & Lee, Ltd. 35
Bentley Acoustical Corpn., Ltd. 96
Berry's (Short Wave), Ltd. 149
Brenell Eng. Co., Ltd. 31
Britain, Chas. (Radio), Ltd. 95
British Institute of Engineering Technology 38
British National Radio School 91
Brown, N. C., Ltd. 150
B.S. Radio and Electrical Store 112
Bulgin, A. F., & Co., Ltd. Edit. 207
Bullers, Ltd. 67

Cannon Electric Co. (G.B.), Ltd. 58
Cardross Eng. Co., Ltd. 47
Carr Fastener Co., Ltd. 67
Celestion, Ltd. 41
Chambers College 97
Clyne Radio, Ltd. 108, 109
Creators, Ltd. 37
C.R.E.I. (London) 11
Cursons, B. W. 146

Daly (Condensers), Ltd. 151
Davis, Jack (Relays), Ltd. 54
Daystrom, Ltd. 4, 5
Dependable Radio Co. 151
Direct T.V. Replacements, Ltd. 90
Dubilier Condenser Co. (1925), Ltd. 18
Dymar Electronics, Ltd. 38

E.K. Electronics (I.A.), Ltd. 64
Electrolube, Ltd. 90
Electronics (Croydon), Ltd. 98, 99
Electrosil, Ltd. 43
Electro-Winds, Ltd. 128
English Electric Valve Co., Ltd. 50
Enthoven Solders, Ltd. 32
Epsylon Industries, Ltd. 44
Erie Resistor, Ltd. 29

Fane Acoustics, Ltd. 30
F.I.A.R. 84
Farnell Instruments, Ltd. 88
Ferrograph Co., Ltd. 6
Finnegan Speciality Paints 148
Fringevision, Ltd. 91

Garrard Eng., Ltd. 14
Gee Bros. (Radio), Ltd. 112
Gladstone Radio 128
Glaser, L., & Co., Ltd. 149
Goldring Mfg. Co., Ltd. 63

Page

Goodmans Industries, Ltd. 20
Goodwin, C. C. (Sales), Ltd. 128
Grampian Reproducers, Ltd. 52

Hart Electronics 145
H.C.D. Research, Ltd. 128
Hall Electric, Ltd. 8
Harmsworth, Townley & Co. 58
Harris Electronics (London), Ltd. 110
Harris, P. 147
Harverson Surplus Co., Ltd. 97
Hatfield Insts, Ltd. 61
Henry's Radio, Ltd. 114, 115
Hinchley Eng. Co., Ltd. 17
Hornton's Electronics 110
Howell's Radio, Ltd. 62
H.P. Radio Services, Ltd. 36

Iliffe Books Ltd. 94, 128, 150
I.M.O. (Electronics), Ltd. 119
Impex Electrical Co. 62
International Correspondence Schools 60
International Rectifiers, Ltd. 26
International Audio Fair 34
I.T.W., Ltd. 28

Jackson Bros. (London), Ltd. 49
J. A. C. Electronics, Ltd. 93
J. T. Supply 97

Kempner, S., Ltd. 84
Keyswitch Relays, Ltd. Cover ii
Kolectric, Ltd. 34

Lasky's Radio, Ltd. 124, 125, 126, 127
Lawson Tubes 148
Leak, H. J. & Co., Ltd. 83
Leak Stockists 85
Ledon Instruments, Ltd. 112
Leevers-Rich Equipment, Ltd. 92
Levell Electronics, Ltd. 13
Lewis Radio Co. 149
Lexor Electronics, Ltd. 62
Light Soldering Developments, Ltd. 56
Linear Products, Ltd. 60
Linstead Electronics, Ltd. 94
London Central Radio Stores 147
Lyons, Claude, Ltd. 16

M.A.C., Ltd. 110
Mail Orders 132
Malvyn Eng. Co., Ltd. 148
Marconi Company, Ltd. 75, 78, 82
Marconi Instruments, Ltd. 19, 21, 51
Mayco Products, Ltd. 145
McMurdo Instrument Co., Ltd. 46, 47
Mills, W. 107
Miniature Electronic Components, Ltd. 62
Modern Book Co. 149
Morhan Exporting Corpn. 40
Moss Watson Co. 148
M. R. Supplies, Ltd. 37
Mullard, Ltd. 74
Multicore Solders, Ltd. Cover iv, 68
Multitone Electric Co., Ltd. 65

Newnes, George, Ltd. 68
Newport Instruments, Ltd. 150
Nicholls, E. R. 150
Nombrex, Ltd. 64

Olson Electronic, Ltd. 146
Orchard & Ind, Ltd. 46
Oxley Developments Co., Ltd. 64

Parker, A. B. 148
Partridge Transformers, Ltd. 47
P.C. Radio, Ltd. 106
Pembridge College of Electronics 66
Peto-Scott, Ltd. 88
Philips, N.V. 79

PAGE

Pinnacle Electronics, Ltd. 15
Post Radio Supplies 147
Premier Radio Co. 108, 109
Proops Bros., Ltd. 104
Pye Telecommunications, Ltd. 2, 3

Quarndon Electronics, Ltd. 150
Quartz Crystal Co., Ltd. 149

RAACO, Ltd. 64
Racal Instruments, Ltd. 45
Radford Electronics, Ltd. 54
Radiatron 93
Radio & T.V. Components (Acton), Ltd. 105
Radio Clearance, Ltd. 146
Radio Components Specialists 113
Radio Exchange 96
Radiospares, Ltd. 148
Radiostructor 93
Ralfe, P. F. 127
Redifon, Ltd. 70, 71
Rollet, H., & Co., Ltd. 149
R.S.C. (Manchester), Ltd. 100, 101

Samsons (Electronics), Ltd. 102
"Science Journal" 121
Scientific Products 150
Service Trading Co. 102, 103
Sifam Electrical Instrument Co., Ltd. 91
Silentbloc, Ltd. 53
Sinclair Radionics, Ltd. 86, 87
S.M.E., Ltd. 40
Smith, G. W. (Radio), Ltd. 116, 117
Smith, John, Ltd. 46
Sona Electronic Co., Ltd. 122
Sotonian Trading Co. 151
Sound Coverage, Ltd. 92
Southern Radio Supply, Ltd. 146
South Supplies (Electrical), Ltd. 123
Sovirel 23
Sowter, E. A., Ltd. 151
Stamford, A. L., Ltd. 147
Stanley-Palmer, G. A., Ltd. 39
Stern-Clyne, Ltd. 108, 109
Stratton & Co., Ltd. 60
Sutton Electronics 151

Tannoy, Ltd. 150
Tape Recorder Centre 111
Tape Recording Magazine 145
Technical Trading Co. 151
Telegraph Condenser Co., Ltd. 80
Telequipment, Ltd. 72
Thorn A.E.I., Radio Valves & Tubes, Ltd. 24, 25
Tricitair 145
T.R.S. Radio 118
Turner, Ernest, Elec. Insts., Ltd. 27

Universal Book Co. 150

Vacwell Engineering Co., Ltd. 59
Valradio, Ltd. 36, 58
Venner Electronics, Ltd. 7
Vitality Bulbs, Ltd. 91
Vortexion, Ltd. 81

Watts, Cecil E., Ltd. 148
Waveforms, Ltd. 149
Webber, R. A., Ltd. 128
West Instruments, Ltd. 66
Weymouth Radio, Mfg. Co., Ltd., The 56
Wharfedale Wireless Works, Ltd. 33, 36, 37
Whiteley Electrical Radio Co., Ltd. 44
Wilkinson, L. (Croydon), Ltd. 120
Winston Electronics, Ltd. 92
Wirecomp Electronics 129

Z. & I. Aero Services, Ltd. 130, 131

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